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Metadata Integration in Electronic Records Management Systems: A Comparative Study of International Best Practices

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ABSTRACT

Metadata plays a critical role in ensuring the authenticity, reliability, and accessibility of electronic records. This study proposes a unified metadata framework for Electronic Records Management Systems (ERMS) by analysing three prominent standards: ISO 23081-1:2017, the Minimum Recordkeeping Metadata Requirements (State Records Act 1997), and the Recordkeeping Metadata Standard (East Renfrewshire Council). A qualitative comparative analysis highlights structural, contextual, and content-and-use metadata elements essential for record creation, classification, maintenance, retention, and disposition. To enhance transparency, an explicit analytical framework was applied to guide the evaluation and ensure validity of findings. The proposed framework integrates best practices to address compliance, system interoperability, and digital preservation. The study concludes with actionable recommendations to support sustainable metadata management in evolving digital environments.

INTRODUCTION

The rapid growth of digital information has made Electronic Records Management Systems (ERMS) essential for organizations to manage records efficiently across their lifecycle. Central to ERMS functionality is metadata, defined as "data about data" which ensures the authenticity, reliability, and long-term usability of records (Asari et al., 2018; Maruping, 2023). Metadata enhances discoverability, accountability, and digital preservation, thereby supporting legal, administrative, and operational needs.

To standardize metadata practices, international and regional guidelines have been established. ISO 23081-1:2017 emphasizes integrating metadata with business processes to maintain record integrity. The Minimum Recordkeeping Metadata Requirements (State Records Act 1997) and the Recordkeeping Metadata Standard (East Renfrewshire Council) offer detailed frameworks for structuring, managing, and preserving metadata throughout a record's lifecycle (State Records of South Australia, 2020; East Renfrewshire Council, 2021). More recent studies, such as Matlala & Ncube (2024) and Kairaityte-Uzupe (2024), further highlight evolving practices in metadata interoperability, security, and usability.

Metadata provides critical contextual details such as creator identity, timestamps, and access history essential for evidentiary value and regulatory compliance (Hlava, 2024). It also supports access controls, system migrations, and archival strategies in dynamic digital environments (Kairaitytė-Užupė, 2024). However, implementation challenges persist, including outdated systems, limited technical expertise, and inadequate integration across platforms (Matlala & Ncube, 2024). Emerging technologies like artificial intelligence and blockchain present opportunities to automate metadata creation and ensure transparency but require careful integration to maintain interoperability and avoid system fragmentation (Hlava, 2024; Wang & Yang, 2021). These studies justify the timeliness of integrating multiple standards into a single framework.

This study proposes an integrated metadata framework that consolidates structural, contextual, and content-and-use elements from leading standards. The framework aims to enhance compliance, interoperability, and preservation, offering a practical solution for effective ERMS deployment in diverse organizational settings. The contribution of this study lies in bridging the gaps identified in existing standards and connecting them with insights from contemporary literature.

OBJECTIVE OF THE STUDY

To develop an integrated metadata framework for ERMS by synthesizing key elements from international metadata standards, with the aim of improving record authenticity, usability, and compliance in diverse organizational contexts.

METHODOLOGY

This study adopted a qualitative research approach combining document analysis and comparative analysis. Document analysis was employed to systematically examine three key metadata standards i.e. ISO 23081-1:2017, the Minimum Recordkeeping Metadata Requirements (State Records Act 1997), and the Recordkeeping Metadata Standard (East Renfrewshire Council), along with five academic publications published between 2018 and 2023. These documents were selected for their relevance to metadata practices across diverse organizational and legal contexts.

Through comparative analysis, the study identified the commonalities, distinctions, and complementary features of the selected standards. An analytical framework was employed, comprising three main evaluation criteria: completeness, interoperability, and sustainability. Completeness refers to the extent to which metadata elements cover lifecycle functions; interoperability refers to the compatibility across organizational systems; sustainability evaluates long-term adaptability to technological and legal changes. The metadata elements were classified into three categories based on their functions in Electronic Records Management Systems (ERMS): structural metadata, contextual metadata, and content and use metadata. A coding matrix was applied to map metadata elements from each standard to these categories, ensuring systematic comparison. This classification enabled a structured comparison and informed the development of an integrated metadata framework applicable across jurisdictions. Selection of elements for the proposed framework was further validated through cross-referencing with contemporary literature and best practices.

This dual-method approach provided a robust foundation for analyzing best practices and aligning theoretical guidelines with real-world implementation challenges.

ANALYSIS AND RESULTS

This section presents the findings derived from the document and comparative analysis of three metadata standards. The analysis was structured around three key types of metadata i.e. structural, contextual, and content and use metadata which represent the core functional areas within Electronic Records Management Systems (ERMS). Each metadata type was examined across the selected standards to identify consistencies, divergences, and unique practices that inform the development of a unified framework. The results also reveal gaps in coverage across standards, which directly motivated the integration into a new framework. The results highlight how these standards address essential recordkeeping functions such as creation, classification, maintenance, retention, and disposition, offering a foundation for integrated metadata management in diverse organizational settings.

Structural Metadata in ERMS

The evaluation of the metadata standards reveals a strong alignment with their respective principles and practical applications, as illustrated in Table 1. Structural metadata, as defined in ISO 23081-1:2017, emphasizes the importance of relationships and hierarchies, including parent-child structures, as well as file formats and encoding schemes that support interoperability across different systems. These components are reflected in the table, including elements such as file format support and logical navigation. Similarly, the Minimum Recordkeeping Metadata Requirements (State Records Act 1997) highlight features such as folder structures, version control, and compliance mechanisms like retention schedules and audit trails, all of which are accurately captured in the table. Furthermore, the Recordkeeping Metadata Standard (East Renfrewshire Council) underscores the critical role of metadata in facilitating system migrations to maintain data compatibility and integrity during transitions. Collectively, these features provide a comprehensive overview of how metadata standards align with their intended recordkeeping functions.

Contextual Metadata in ERMS

Contextual metadata demonstrates strong alignment with the reviewed standards and is further detailed in Table 1. Lifecycle management—particularly the inclusion of the creator's identity and the context in which a record is created—is a key requirement in ISO 23081-1:2017. These aspects are represented in the table through elements such as traceability and workflow integration. The Minimum Recordkeeping Metadata Requirements (State Records Act 1997) emphasize timestamping, compliance, and other critical lifecycle activities, including record transfers and disposals. These are reflected in the table through features such as event tracking and regulatory metadata. Additionally, the Recordkeeping Metadata Standard (East Renfrewshire Council) acknowledges the dynamic nature of metadata, which must adapt to legal and system changes over time. This adaptability is also captured in the table through variations in regulatory context and the evolving nature of metadata elements. Collectively, these components illustrate how contextual metadata supports effective recordkeeping practices across different standards.

Content and Use Metadata in ERMS

The elements of content and use metadata show a strong alignment with the reviewed standards. In terms of compliance processes, ISO 23081-1:2017 incorporates descriptive elements such as titles, keywords, summaries, and access permissions to enhance discoverability and ensure accountability. These elements are represented in Table 1 through features like usage logs, audit trails, and search-enhancing

attributes. Similarly, the Minimum Recordkeeping Metadata Requirements (State Records Act 1997) emphasize the use of classification codes, unique identifiers, and role-based access controls. These are reflected in the table under classification mechanisms and secure access control systems. The Recordkeeping Metadata Standard (East Renfrewshire Council) focuses on dynamic tagging and user activity logging to support ongoing usability. This is captured in the table through references to adaptive tagging and features that ensure the long-term accessibility and relevance of records.

Table 1: Comparison of Metadata Types Across Selected Standards

Types of Metadata	ISO 23081-1:2017 – Metadata for Records – Part 1: Principles	Minimum Recordkeeping Metadata Requirements (State Records Act 1997)	Recordkeeping Metadata Standard (East Renfrewshire Council)
Structural Metadata	Describes relationships and hierarchies of records, such as parent-child structures and aggregation levels.	Includes file structures for folder arrangements and version control.	Metadata supports system migrations to preserve data integrity during transitions.
	File formats and encoding standards (e.g., PDF, XML) ensure usability and compatibility across systems.	Tracks version histories, changes, and timestamps for accountability.	Highlights digital file formats and their importance for long-term preservation.
	Metadata supports logical navigation through structured organization of records.	Emphasizes compliance-related structures like retention schedules and audit trails.	Metadata helps ensure compatibility across changing systems.
Contextual Metadata	Captures creation details like creator identity, creation date, and business process context.	Provides metadata for creation and modification timestamps.	Recognizes dynamic metadata, adapting to changes in regulations and systems.
	Links metadata to record lifecycle stages such as creation, modification, and disposition.	Tracks events like transfers and disposals to support lifecycle management.	Records metadata about creation environments, including software and tools.
	Emphasizes traceability and context through integration with business workflows.	Includes regulatory metadata for compliance with legal requirements.	Aligns records with broader regulatory and operational contexts.

Content and Use Metadata	Metadata includes descriptive elements such as titles, keywords, and summaries for easier discovery.	Emphasizes classification codes and unique identifiers to enable efficient search and retrieval.	Dynamic tagging adapts to user interactions and system changes over time.
	Tracks access permissions and usage logs for accountability.	Includes audit trails for tracking all interactions with records.	Logs user activities and system events for long-term usability.
	Supports user interactions through metadata-driven access controls.	Defines access permissions through role-based metadata.	Enhances content discoverability through keywords and contextual metadata.

ESTABLISHING AND CLASSIFYING THE METADATA ELEMENTS FOR EFFECTIVE RECORDKEEPING

Metadata elements describe record's attributes, context, and management to ensure proper handling, accessibility, and compliance throughout its lifecycle. This study analyses three standards focusing on the recordkeeping functions of creation, classification, maintenance, retention, and disposition. The selected standards are ISO 23081-1:2017, Minimum Recordkeeping Metadata Requirements (State Records Act 1997) and, the Recordkeeping Metadata Standard (East Renfrewshire Council).

Metadata on Record Creators

When a record is created, it is essential to specify the individual, organization, or system as the responsible entity. Throughout the lifecycle of record, ISO 23081-1:2017, and the Minimum Recordkeeping Metadata Requirements (State Records Act 1997) insists on recording the creator's identity to ensure accountability and traceability. The Recordkeeping Metadata Standard tasks the accountability to specific units or department within local government body.

Assigning Security Levels

Focusing on effective management and access control, records are classified based on privacy and security criteria. ISO 23081-1:2017 identify metadata's sensitivity levels, to allow access control and retention policies within the organization. Both the Minimum Recordkeeping Metadata Requirements (State Records Act 1997), and Recordkeeping Metadata Standard implement classification categorization to maintain records confidentiality and compliance, where records are classified into Public; or, Confidential; or Restricted categories.

Managing Access Controls

As part of the records' maintenance element, access is limited to authorized persons or groups based on the records' classification of sensitivity and confidentiality. In ISO 23081-1:2017, metadata elements determine access right, only specific role has the access rights to ensure information and access

protection. The Minimum Recordkeeping Metadata Requirements (State Records Act 1997) focus on the access control metadata to restrict access to the sensitive records. And The Recordkeeping Metadata Standard emphasizes access control based on departmental roles and classifications.

Protecting Records Through Locking

All three standards utilize locking mechanism in preserving records' integrity and authenticity. By capturing the records' terminal state, ISO 23081-1:2017, the Minimum Recordkeeping Metadata Requirements (State Records Act 1997), and the Recordkeeping Metadata Standard use metadata to lock records against falsification, changes, and alteration.

Scheduling Retention

ISO 23081-1:2017 ensure compliances with legal and regulatory requirements, by utilizing retention metadata to define the retention period, effectively managing records' lifecycle, emphasizing the retention duration. The Minimum Recordkeeping Metadata Requirements (State Records Act 1997) connects retention schedules with the State Records Act 1997, while The Recordkeeping Metadata Standard uses Business Classification Scheme to link with retention metadata.

Disposition - Final Actions for Records

ISO 23081-1:2017 and The Recordkeeping Metadata Standard use the fundamental concept of disposition metadata to define the archiving or destruction of records after the retention period. The Minimum Recordkeeping Metadata Requirements' (State Records Act 1997) level of detail provides more specific guidance and focus on the disposition activity.

Below, Table 2 summarizes the main points based on the three international recordkeeping metadata chosen: ISO 23081-1:2017, Minimum Recordkeeping Metadata Requirements (State Records Act 1997), and Recordkeeping Metadata Standard (East Renfrewshire Council).

Table 2: Metadata Elements Across Selected Standard

Metadata Elements	ISO 23081-1:2017	Minimum Recordkeeping Metadata Requirements (State Records Act 1997)	Recordkeeping Metadata Standard (East Renfrewshire Council)
Creator Information	Captures the identity of the creator (individual, organization, or system) to ensure accountability and traceability throughout the record lifecycle.	Requires metadata documenting the creator's details to comply with legal and organizational standards.	Focuses on capturing departmental or office-level information to assign responsibility for record creation.
Security Classification	Specifies metadata for sensitivity levels, enabling organizations to regulate access and	Implements classification labels such as Public, Confidential, and Restricted to protect sensitive information.	Adopts a classification system aligned with local government policies, categorizing records as

	retention practices based on sensitivity.		Public, Restricted, or Confidential.
Access Controls	Provides metadata elements for role-based permissions to regulate who can view, modify, or interact with specific records.	Emphasizes access control metadata to ensure that only authorized personnel can access sensitive records.	Ties access control metadata to departmental roles and security classifications, ensuring permissions are applied appropriately.
Record Locking	Includes metadata to lock finalized records, preserving their integrity, authenticity, and evidentiary value.	Mandates the use of locking mechanisms to protect finalized records from tampering or accidental changes.	Applies locking measures to ensure finalized records remain unaltered and legally valid.
Retention Information	Incorporates metadata elements for defining retention periods and triggers to comply with legal and operational requirements.	Ties retention schedules to compliance with the State Records Act 1997 and organizational policies.	Links retention metadata to the Business Classification Scheme, ensuring records are retained appropriately.
Disposition Actions	Specifies metadata for managing archiving, destruction, or transfer actions after the retention period ends.	Outlines metadata for archiving, destruction, or transfer to another authority to handle records at the end of their lifecycle.	Defines final actions for records, including archiving or destruction, ensuring obsolete records are securely disposed of.

ESTABLISHING NEW RECORDKEEPING METADATA FRAMEWORK

In the context of ERMS, ISO (2017) defines a metadata framework as a system that complies with a set of guidelines or standards to ensure metadata's authenticity, reliability, and usability. The framework standardised accuracy, completeness, and accessibility of metadata, and providing consistency in the preservation, retrieval, and use of digital records across various systems.

According to Wang & Yang (2021), maintaining data integrity and consistency over time and adapting to evolving standards are some of the key challenges in metadata management. To address these challenges, we propose the integration of ISO 23081-1:2017, Minimum Recordkeeping Metadata Requirements (State Records Act 1997), and Recordkeeping Metadata Standard (East Renfrewshire Council) to create a comprehensive and reliable metadata framework. The discussion builds on the analysis by explicitly linking the findings from the standards with gaps identified in literature. For example, ISO 23081-1:2017 ensures structural completeness but lacks flexibility in adapting to new technologies, while the State Records Act 1997 standard emphasizes compliance but under-specifies interoperability. The East Renfrewshire Council standard addresses migration issues but provides limited detail on long-term preservation strategies. (Reviewer 3): By aligning these findings with recent research (e.g., Hlava, 2024;

Matlala & Ncube, 2024), the study demonstrates how the proposed framework addresses these shortcomings.

Based on below Table 3, the analysis from the 3 standards were evaluated. This was summarised to make a new recordkeeping metadata framework.

Table 3: Summarized based on 3 Standards to establish a new Recordkeeping Metadata Framework

Recordkeeping Metadata Elements	**ISO 23081-1:2017**	**Minimum Recordkeeping Metadata Requirements (State Records Act 1997)**	**Recordkeeping Metadata Standard (East Renfrewshire Council)**	**Type of Metadata**
Creation	Captures creator details (Ali Ahmad, Jabatan Kewangan, 2025-01-18).	Requires creator information for compliance and traceability.	Identifies the department/office responsible for record creation.	Contextual Metadata
Classification	Defines security classifications (Sulit, Awam).	Implements classification tiers (Public, Confidential, Restricted).	Aligns classification levels with local policies (Public, Restricted, Confidential).	Content and Use Metadata
Maintenance	Tracks updates, modifications, and lifecycle events (Edited by Aisyah, 2025-02-01).	Records lifecycle details like approvals and administrative changes.	Ensures data integrity through version control (Version 3.1) and validations.	Contextual, Structural, and Preservation Metadata
Retention	Defines retention schedules (Retain for 7 years).	Links retention policies to legal requirements (State Records Act 1997).	Connects retention metadata to functional classifications (Business Classification Scheme).	Structural and Preservation Metadata
Disposition	Specifies final actions(Archiving, Destruction, or Transfer).	Records disposition actions like destruction or archiving.	Details archival transformations (Converted to PDF/A; Compressed to ZIP).	Content and Use, Structural and Technical Metadata

Access and Rights	Defines access permissions and role-based controls (Only accessible by Finance Team).	Emphasizes secure access for sensitive records.	Implements departmental access restrictions based on classifications (Confidential records limited to HR).	Rights Metadata
Preservation	Records actions like format migrations (Migrated to a new system in 2030).	Ensures archival formats and authenticity through validations.	Tracks preservation actions such as checksum validation or reformatting for long-term access.	Preservation and Technical Metadata
Technical	Logs encryption methods (AES256 Encryption) and file specifications	Records system specific details for accountability.	Documents hardware or software configurations used in record creation or preservation.	Technical Metadata

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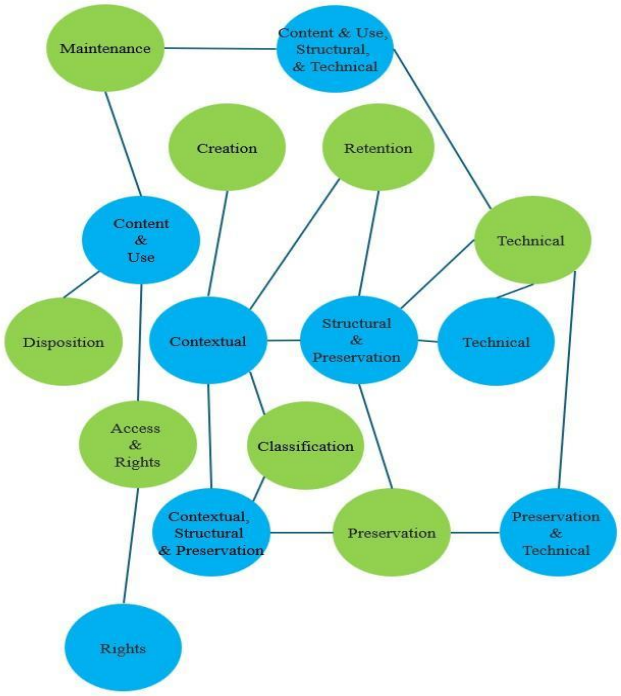

Figure 1: Relationship between types of metadata and recordkeeping metadata elements

CONCLUSION

The conclusion of this report encompasses the key findings and outcomes from the case study of metadata standards and ERMS integration, focusing on the proposed metadata framework, and insights for the future development and evolution of metadata standards, and approaches for framework implementation in organisations. The proposed integration of three standards creates a comprehensive and consistent metadata standard that aligns with global best practices. Trust attributes are developed to ensure metadata trustworthiness. The framework includes detailed trust domains for each stage of the metadata lifecycle, along with definition of stakeholder's role and responsibilities. The implementation consists of establishing metadata governance structures and policies to maintain quality and ensure compliances with the standards. Validation and verification methods are developed to gain trust and reliability, and protect metadata from unauthorised access. Most importantly, the framework is justified as a direct response to gaps identified in both standards and recent research findings.

FUTURE RECOMMENDATIONS

This research has yielded findings and potential implications for future development of metadata standards. More comprehensive and robust metadata frameworks can be created by integrating multiple standards. In future, synchronization of multiple standards should prioritize to improve compatibility. To enhance metadata trustworthiness, metadata management must incorporate trust attributes. AI, ML, and blockchain should be considered to automate metadata processes and enhance security and reliability. With the evolution of metadata frameworks, emphasis on user-friendly design will ensure systems remain accessible and serve stakeholders.

Strategic and systematic approach contributes to the accomplishment of the proposed metadata framework implementation. Training and awareness programs are given to employees, to ensure understanding on the importance of metadata, and their specific roles and responsibilities. Successful implementation of a metadata framework is underpinned by the importance of strong stakeholder involvement, and optimal resource management, pilot testing framework validation, consistent metadata quality monitoring, and regular audits and corrective actions. These recommendations resulted in the successful implementation of a metadata framework within organizations, ensuring records' authenticity, integrity, and usability. Future work should also test the proposed framework empirically in organizational case studies to confirm its applicability.

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