



# Digital repositories as knowledge infrastructure: Institutional management strategies in the open access era

Primus Sanbein

Sekolah Pascasarjana, IPB University, Bogor, Indonesia

Corresponding Author: [primsanbein@gmail.com](mailto:primsanbein@gmail.com)

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## ABSTRACT

Digital repositories have increasingly been recognized as integral elements of the knowledge infrastructure in higher education and research environments. Their role extends beyond mere storage of scholarly works to include preservation, dissemination, and equitable access to academic knowledge in accordance with open-access principles. However, many institutional repositories continue to face persistent challenges, including fragmented governance structures, limited system interoperability, suboptimal metadata practices, and low user engagement. To address these issues, this study adopts a Conceptual Literature Review (CLR) approach to synthesize interdisciplinary insights on repository management in the context of open access. The findings reveal four interconnected strategic dimensions that influence repository sustainability: governance and policy, technological infrastructure, institutional capacity and human resources, and user-oriented services. These dimensions are subsequently integrated into a conceptual model that emphasizes their systemic interrelationships within institutional knowledge management. This study reframes digital repositories not simply as technical storage platforms, but as governance-driven knowledge infrastructures that facilitate the circulation and strategic utilization of scholarly outputs. The proposed framework provides analytical direction for enhancing institutional preparedness and ensuring the long-term sustainability of repositories within the broader open science landscape.

## ABSTRAK

Repositori digital semakin diposisikan sebagai komponen strategis dalam infrastruktur pengetahuan di perguruan tinggi dan lembaga penelitian. Fungsinya melampaui penyimpanan karya ilmiah, mencakup pelestarian, diseminasi, dan penyediaan akses terbuka terhadap pengetahuan akademik sesuai dengan prinsip open access. Meskipun demikian, pengelolaan repositori masih menghadapi tantangan berupa fragmentasi tata kelola, keterbatasan interoperabilitas sistem, praktik metadata yang belum terstandar, kapasitas sumber daya manusia yang terbatas, serta rendahnya keterlibatan pengguna. Artikel ini menggunakan pendekatan Conceptual Literature Review (CLR) untuk menyintesis berbagai perspektif interdisipliner mengenai pengelolaan repositori di era keterbukaan informasi. Kajian ini mengidentifikasi empat dimensi strategis yang saling terkait, yaitu: (1) kebijakan dan tata kelola, (2) infrastruktur teknologi, (3) kapasitas kelembagaan dan sumber daya manusia, serta (4) layanan berbasis pengguna. Keempat dimensi tersebut disusun dalam model konseptual yang menegaskan keterkaitan sistemik dan relevansinya dalam manajemen pengetahuan institusional. Model yang diusulkan memperluas pemahaman repositori sebagai *governance-based knowledge infrastructure* serta memberikan kerangka analitis bagi penguatan kesiapan dan keberlanjutan repositori secara kelembagaan. Studi ini berkontribusi secara konseptual terhadap pengembangan ekosistem pengetahuan yang inklusif, adaptif, dan berkelanjutan dalam lanskap sains terbuka.

**Keywords:** Digital repository; Knowledge infrastructure; Open access; Conceptual literature review; Institutional governance

## 1. INTRODUCTION

Over the past two decades, advances in digital technology have significantly reshaped knowledge governance within educational and research institutions. The production, storage, and dissemination of scientific information are no longer dependent on print-based systems or physical access, but are increasingly embedded in globally interconnected digital environments. This transformation goes beyond technology. It also reflects structural and cultural changes that influence how institutions maintain accountability, expand research dissemination, and sustain knowledge over time. At the

same time, rapid developments in information technology have introduced more complex challenges related to the accessibility and long-term sustainability of academic knowledge. In this context, digital repositories have emerged as an important response, functioning not only as storage platforms for scholarly materials, but also as open dissemination channels that enhance transparency, increase research visibility, and support scientific collaboration (Lin et al., 2024).

Within the broader open knowledge ecosystem, digital repositories play a bridging role between knowledge production and its wider societal use. They enable knowledge to circulate more efficiently across disciplines, institutions, and national boundaries in a structured manner. Open access to research outputs and scientific data reflects key principles of information equity, sustainable development, and global collaboration within the Open Science framework (UNESCO, 2021). From this perspective, strengthening digital repositories should not be viewed solely as a technological priority, but also as an institutional and societal responsibility of higher education in sustaining knowledge ecosystems.

From a broader perspective, digital repositories are increasingly understood not merely as systems for storing scientific documents, but as components of knowledge infrastructure that support the production, curation, and dissemination of knowledge within academic environments. The concept of knowledge infrastructure emphasizes the interconnected roles of technology, institutional governance, organizational practices, and the active participation of academic communities in shaping an open and sustainable knowledge ecosystem. In this sense, repositories hold strategic potential as integrative nodes that connect multiple stages of the knowledge life cycle, from research production to its application in learning, innovation, and public policy.

However, the implementation of institutional repositories in many developing contexts, including Indonesia and parts of Africa, continues to face significant challenges. Common issues include limited technological infrastructure, low levels of digital literacy, and weak institutional policy support for long-term sustainability. In addition, limited managerial commitment and the absence of incentive mechanisms for academic communities remain key barriers to repository development in higher education. As a result, repositories are often treated merely as administrative archives rather than as integral components of institutional knowledge management systems (Kari & Orji, 2022).

Technical challenges also arise from low metadata quality and a lack of interoperability between repositories and other academic information systems. These conditions limit systems' ability to interconnect, perform effective data curation, and provide optimal search services for users. The development of digital repositories requires standardized policies, consistent classification systems, and strategic collection curation processes in order to support their functions sustainably (Roy et al., 2022).

The success of digital repositories is also strongly influenced by institutional support and adaptive governance. Integration of technology, internal policies, and the active involvement of strategic campus units has been shown to be key to developing effective institutional repositories. Cross-functional management involving libraries, information technology centers, and academic leadership is an important part of a solid coordination system that strengthens digital repositories (Bokoh et al., 2024).

In addition to structural and institutional factors, user access aspects also determine repository effectiveness. Experience during the COVID-19 pandemic shows that digital repositories play an important role in maintaining continuity of information access for students in areas with limited access to physical libraries, so that repositories not only function for researchers, but also support learning processes and broader academic capacity development (Shilaki et al., 2023).

However, much of the existing literature still examines digital repositories through fragmented lenses, focusing separately on technical aspects, policy frameworks, or user services. An integrative

perspective that positions repositories as part of institutional knowledge infrastructure remains relatively underdeveloped, particularly in developing countries, where resource limitations and governance fragmentation are common. In practice, sustainable repository development requires more than isolated improvements. It calls for strategic planning that integrates system design, content curation, human resource readiness, and alignment with institutional knowledge management structures, enabling repositories to function effectively as nodes for knowledge accumulation and dissemination.

In the Indonesian context, the need to strengthen institutional repositories has become increasingly urgent. This urgency is driven by growing demands for academic accountability, performance evaluation systems based on publication outputs, and national policies promoting open access to scientific information. Although many institutions have established their own repositories, their integration into broader knowledge management architectures remains limited. In many cases, repositories develop as technical or administrative initiatives without clear links to long-term institutional strategies. These conditions risk constraining their potential to serve as instruments of knowledge governance and to contribute to the enhancement of academic reputation (Puspita et al., 2024).

At the same time, recent studies tend to emphasize case studies or technical evaluations within specific institutional settings. While these contributions are valuable empirically, efforts to develop a more comprehensive theoretical synthesis remain limited. In particular, the relationships among governance, technological infrastructure, institutional capacity, and user experience are rarely articulated within a single analytical framework. This gap is important, given that repositories have the potential to operate not only as systems for scientific documentation but also as strategic mechanisms for strengthening accountability, institutional reputation, and contributions to sustainable development agendas.

In response to these limitations, this article examines digital repositories as knowledge infrastructure within the broader context of open access and institutional transformation. It proposes a conceptual framework for repository management that incorporates four interrelated strategic dimensions: governance and policy, technological infrastructure, institutional capacity and human resources, and user services. The primary contribution of this study is an integrative model that captures the systemic relationships among these dimensions, providing a basis for strengthening institutional repositories, particularly in developing contexts. From this perspective, digital repositories are understood not merely as technical systems but as epistemic and institutional spaces that play a strategic role in advancing knowledge democratization and supporting long-term research and learning capacity.

## **2. LITERATURE REVIEW**

### **2.1 Digital Repositories as Knowledge Infrastructure**

Digital repositories have evolved from simple storage facilities into strategic components of the knowledge infrastructure that support scientific collaboration, information preservation, and the development of open research ecosystems. This transformation is not driven solely by advances in technology. It is also shaped by the degree of institutional integration, the design of the system architecture, and the openness and accessibility of data. From a knowledge infrastructure perspective, repositories play a key role in facilitating the wide dissemination of knowledge, improving efficiency in cross-institutional collaboration, and serving as important nodes within the research life cycle.

The development of research infrastructure, however, is often constrained by a lack of standardization and weak coordination across institutional units. As a result, repositories are frequently not fully integrated into broader institutional systems (Lorenz et al., 2023). In response,

more recent approaches, such as cloud-native data lakehouse architectures, have been introduced to enhance interoperability and improve the efficiency of managing scientific data (AbouZaid et al., 2025). At the same time, repositories are increasingly positioned within larger knowledge ecosystems that connect knowledge creation and dissemination in more transparent and collaborative ways (Rådberg & Löfsten, 2023).

The integration of repositories with research information systems, such as CRIS (Current Research Information System), further illustrates this shift. Repositories are no longer limited to storage functions, but also serve as mechanisms for consolidating research data within open science policy frameworks (Tapia, 2024). They are also recognized as digital archives that help preserve institutional memory and ensure the continuity of knowledge over time (Lorenz & Konečný, 2023). In addition, models such as Digital Repository as a Service (D-RaaS) have been developed to combine cultural preservation functions with broader, more standardized public access (Tsipi et al., 2023).

Despite these developments, sustainability remains a critical concern. Weak governance structures and a lack of long-term planning can lead to the disappearance of repositories, posing risks to the stability of research data (Strecker et al., 2023). Efforts to promote self-deposit practices among academic communities—supported by citation databases—highlight the importance of incentive mechanisms and system integration in increasing user participation (Lake & Regenauer, 2024). At the same time, repositories contribute to expanding green access to research outputs as part of the broader open science movement (Mishra & Kumar, 2023).

Contemporary literature reflects a significant shift in how digital repositories are understood. While previously regarded primarily as technical systems for storing and retrieving documents, repositories are now conceptualized as a systemic knowledge infrastructure. This perspective situates repositories within a broader knowledge governance architecture that brings together technology, policy, institutional structures, and collaborative practices within a unified research ecosystem. Consequently, the focus of management shifts from document handling toward governance-oriented and interoperable knowledge management.

Nevertheless, much of the existing literature still addresses repositories in a fragmented manner, focusing separately on technical, policy, or institutional dimensions. Systematic conceptual integration across these dimensions remains limited. This indicates that digital repositories, when viewed as knowledge infrastructure, still require deeper and more comprehensive theoretical exploration to better understand the complex relationships among their components.

## 2.2 Open Access Principles and Their Relevance to Repositories

Open access principles provide a foundational basis for transforming the global scientific ecosystem into one that is more inclusive, transparent, and collaborative. In the context of digital repositories, openness extends beyond mere access to publications and research data. It also encompasses ethical considerations in use, system interoperability, and broader efforts toward democratizing knowledge.

The growing integration of artificial intelligence into repositories and digital libraries illustrates how technology can enhance personalized knowledge dissemination while also improving inclusion for marginalized groups (Ikwuanusi et al., 2023). At the same time, the effectiveness of open information dissemination is shaped by social dynamics, including the speed of diffusion, levels of exposure, and forms of resistance within society (Zhou, 2022). These conditions suggest that open access should not be understood solely as a technical matter, but also as a social and institutional phenomenon.

Although commitment to open data continues to expand, its implementation remains uneven across disciplines and institutional settings (Jiao et al., 2022). The presence of digital technology alone does not necessarily lead to effective knowledge collaboration without adequate organizational structures and incentive mechanisms (Deng et al., 2023). Evidence from the industrial sector indicates that open knowledge dissemination can positively influence innovation performance (Lee, 2025), while in the health sector, openness is often operationalized through data-driven public advocacy on digital platforms (Han et al., 2023).

However, the expansion of openness also introduces ethical challenges. Among these is the increased risk of plagiarism in open repositories (Puspita et al., 2024). In addition, standardization and interoperability are critical requirements to ensure that repositories operate in a credible and sustainable manner across sectors (Bosfield et al., 2025). Experiences from multidisciplinary research infrastructure projects further demonstrate that implementing open access requires complex data integration as well as robust governance arrangements (Ohnemus et al., 2024).

From a broader perspective, openness is not determined solely by technological availability. It is also shaped by governance structures, institutional capacity, and the readiness of organizational culture. Several studies highlight the tension between the normative ideal of openness and its practical implementation, which is often partial, fragmented, or merely formalistic. In many cases, repositories may provide open access to scientific outputs yet still fall short in ensuring quality curation, interoperability, and the long-term sustainability of managed knowledge.

Taken together, open access can be understood not only as a normative principle but also as an ongoing process of institutional transformation that integrates technical, ethical, and organizational dimensions. Nevertheless, existing literature tends to address these dimensions in isolation, leaving the relationships among technological systems, governance arrangements, and institutional practices insufficiently articulated. This gap underscores the need for deeper theoretical exploration to better understand open access within the broader dynamics of knowledge infrastructure.

### 2.3 Repository Management Strategies in the Literature

Effective management of digital repositories requires a comprehensive strategy that integrates technical, institutional, and governance dimensions. A knowledge infrastructure perspective suggests that resistance to digital transformation often stems from weak alignment between information systems and broader institutional strategies (Andersson & Eidenskog, 2023). In this regard, the implementation of FAIR principles (Findable, Accessible, Interoperable, Reusable) plays a critical role in ensuring that repositories can support meaningful cross-disciplinary knowledge exchange (Gómez & Bernal, 2023).

Security and long-term sustainability are equally central in repository management. The emergence of cyber threats, including DDoS attacks, underscores the need for adaptive and risk-based protection mechanisms within institutional repositories (Singh & Gupta, 2022). From an organizational standpoint, factors such as institutional culture and internal support significantly influence the success of repository adoption (Nailalmarom et al., 2025). In addition, the ability of institutions to manage knowledge in an adaptive manner becomes a key determinant in maintaining system sustainability (Kaur, 2023).

Strengthening human resource capacity is another essential component of repository management. This includes the development of competencies through information management curricula as well as continuous technical training (Stek et al., 2025). Collaboration across institutions in developing efficient and context-sensitive repository systems further reinforces the infrastructure dimension (Noumonvi et al., 2023). At the policy level, harmonization and adherence to interoperability

standards, such as OAI-PMH, are also important indicators of repository strengthening at a national scale (Piedboeuf et al., 2023).

The literature on repository management strategies shows that system success is determined not only by technological sophistication but also by the integration of system architecture, institutional governance, organizational culture, and incentive mechanisms that encourage user participation. Sectoral or short-term project-based approaches tend to produce repositories that operate administratively but are not fully integrated into institutional decision-making systems. In this context, repositories that are connected to academic information systems, research management, and faculty performance evaluation are viewed as occupying strategic positions in policy-based knowledge governance and accountability.

However, most studies still discuss management strategies within single dimensions, whether technical, institutional, or policy-related, without systematically elaborating the interconnections among these dimensions. Conceptual integration of technological aspects, governance, and organizational dynamics has not been widely discussed in the literature. This condition shows that understanding of repository management strategies is still evolving and requires deeper, more comprehensive theoretical exploration.

## 2.4 The Role of Human Resources and Institutions

The success of digital repositories is determined not only by technology and policy but also by the readiness of human resources and supporting institutional structures. Data stewardship practices in the context of AI-based research require high curatorial and ethical competencies in managing complex data (Taddese et al., 2025). The adoption of digital technology is also strongly influenced by digital literacy and the collaborative capabilities of human resources (Priya et al., 2025).

The success of digital-based information systems is often determined by organizational readiness and support staff, rather than solely by technological sophistication (Bilquise et al., 2024). Repositories as part of the knowledge infrastructure also require long-term support and sustainable institutional strategies (Narlock et al., 2024). Knowledge management maturity assessment frameworks show that integration of processes, technology, and organizational culture becomes a determining factor in repository system effectiveness (Bougoulia & Glykas, 2023).

The role of metadata specialists is becoming increasingly critical in connecting research outputs with sustainable development agendas and SDG indicators (Nel et al., 2024). At the same time, effective digital knowledge management has been shown to enhance organizational efficiency and support continuity in the face of change (Gupta et al., 2023). In this context, repositories need to be managed by adaptive and collaborative teams capable of aligning technological strategies with broader institutional missions.

Beyond technical considerations, repository management is also closely tied to organizational capacity. As highlighted by Gupta et al. (2023) and further emphasized by Sanbein (2026), the sustainability of knowledge practices depends on institutional readiness, including literacy and organizational capability. This suggests that repository development requires not only technical expertise but also a supportive institutional environment that enables knowledge to be managed and utilized effectively.

The literature consistently indicates that challenges in repository implementation are not purely technical. Instead, they are often rooted in institutional configurations and the capacity of human resources that support them. Fragmentation across organizational units, weak cross-functional coordination, and the absence of a long-term strategic vision frequently result in repositories operating merely at an administrative level, lacking sufficient strategic integration. These conditions highlight

that repositories should be understood as complex organizational constructs in which technological effectiveness is closely linked to collaborative culture, leadership, and governance structures.

Accordingly, human resource readiness and institutional strength can be viewed as fundamental determinants of repository sustainability. The integration of technical skills, managerial capacity, and internal policy support reflects the close interdependence between human, organizational, and technological dimensions. However, existing studies still tend to address these aspects separately, leaving the relationships among them insufficiently explored systematically.

### 3. METHOD

This study adopts a Conceptual Literature Review (CLR) approach to develop a theoretical synthesis of digital repositories as knowledge infrastructure within the open access framework. CLR is designed to integrate, reinterpret, and extend conceptual insights derived from cross-disciplinary literature. Such an approach is particularly suitable for dynamic and rapidly evolving fields, where ideas and empirical findings are often scattered across diverse theoretical perspectives (Snyder, 2019). Moreover, CLR enables the identification of recurring conceptual patterns, relationships among key ideas, and existing analytical gaps through a reflective and interpretative process (Torraco, 2016).

In this study, CLR is employed to construct a conceptual model of digital repositories that integrates governance, technological infrastructure, institutional capacity, and user services from a systemic perspective. The emphasis is not placed on quantifying or aggregating empirical evidence, but rather on exploring conceptual relationships that underpin the theoretical positioning of repositories within institutional knowledge management architecture. In this sense, the literature is treated as a source of ideas that are critically examined and synthesized into a coherent analytical framework.

The literature search was carried out in several stages using academic databases, including Scopus, DOAJ, Google Scholar, and Garuda. This process was complemented by the inclusion of policy documents and international reports from organizations such as UNESCO, SPARC, and OpenAIRE. The selected sources consist of recent publications highly relevant to digital repository management, knowledge infrastructure, and open access. A purposive selection strategy was applied, prioritizing conceptual contribution, analytical depth, and alignment with the study's focus, rather than relying solely on quantitative representation.

Data analysis followed a thematic-interpretative approach. Initially, the literature was reviewed to identify recurring concepts within discussions on digital repositories, including governance, interoperability, organizational capacity, and user experience. These concepts were then mapped to explore their relationships and potential tensions across dimensions. Subsequently, a process of conceptual integration was undertaken to develop a relational structure that captures systemic patterns in repository management. This process was iterative in nature, with interpretations continuously refined through repeated engagement with the literature to ensure analytical consistency (Webster & Watson, 2002).

Conceptual validity in this CLR is established by the coherence of arguments, the traceability of sources, and the degree of integration among the concepts that form the proposed model. The synthesis is not conducted mechanically; instead, it involves critical reflection on the underlying assumptions of each theoretical perspective. As a result, the model developed does not merely summarize existing literature but reconstructs the relationships among dimensions within a more integrated analytical framework.

The outcome of this process is a conceptual model that positions digital repositories as knowledge infrastructure, characterized by interdependent relationships among governance and

policy, technological infrastructure, institutional capacity, human resources, and user services. The model is analytical and reflective in nature, and is intended to serve as a theoretical foundation that can be further examined and refined through empirical research across different institutional contexts.

To maintain analytical coherence, the synthesis also involved comparing and grouping arguments with conceptual similarities, followed by identifying relational patterns that remain consistent across various contexts in the literature. This approach helps to surface implicit assumptions embedded in repository discourse while avoiding the oversimplification of complex concepts. Consequently, the resulting framework is not only descriptive but also interpretative and exploratory, allowing for a more nuanced understanding of digital repositories as complex institutional constructs. This reflective process ensures that the model possesses sufficient conceptual depth and internal consistency.

#### 4. RESULTS AND DISCUSSION

This section presents the results of the conceptual synthesis of the literature analyzed through a thematic approach within the framework of a Conceptual Literature Review. The analysis focuses on identifying recurring conceptual patterns in studies of institutional repositories. The results of this synthesis show four strategic dimensions that consistently appear in the literature and are summarized in Table 1.

**Table 1.** Literature Synthesis of Digital Repository Management

| Strategic Dimension                        | Conceptual Focus                                                     | Key Findings in the Literature                                                                                                                                                                                                                                   | Main References                                                         |
|--------------------------------------------|----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| Governance and policy                      | Repository policies, open access, and data management standards      | Repository success is influenced by the existence of clear institutional policies, adoption of open access principles, and implementation of standards such as FAIR to ensure openness and sustainability of scientific data.                                    | Gómez & Bernal (2023); Puspita et al. (2024); UNESCO (2021)             |
| Technological infrastructure               | System interoperability, data security, and repository architecture  | Interoperable and secure technological infrastructure is an important prerequisite for repository sustainability. Integration with research information systems and the use of modern digital architecture improve the efficiency of scientific data management. | AbouZaid et al. (2025); Singh & Gupta (2022); Tapia (2024)              |
| Institutional capacity and human resources | Repository manager competencies and organizational support           | Repository success does not only depend on technology, but also on organizational capacity, metadata management competencies, and institutional support that enables cross-unit coordination.                                                                    | Taddese et al. (2025); Bougoulia & Glykas (2023); Narlock et al. (2024) |
| User services and experience               | System accessibility, user participation, and repository utilization | A user-centered approach increases academic community participation in self-archiving and reuse of scientific knowledge, thereby strengthening the function of repositories as a medium for knowledge dissemination.                                             | Ikwuanusi et al. (2023); Lake & Regenauer (2024); Mishra & Kumar (2023) |

Building on this synthesis, the following section discusses each dimension in more detail. The following discussion elaborates each strategic dimension in digital repository management in greater depth.

##### 4.1 Four Strategic Dimensions of Digital Repository Management

Digital repositories as knowledge infrastructure cannot be narrowly understood as technical systems or administrative mechanisms for storing scientific documents. A conceptual synthesis of recent literature shows that repositories are strategic constructs formed by the interaction among various institutional, technological, and organizational-practice dimensions that influence one another. Through a process of thematic integration of various recent studies, this discussion identifies

four main dimensions in digital repository management, namely: (1) governance and policy, (2) technological infrastructure, (3) institutional capacity and human resources, and (4) user services and experience. These four dimensions do not stand alone as separate categories, but form a systemic configuration that determines the direction, effectiveness, and sustainability of repositories within the open knowledge ecosystem.

The governance and policy dimension serves as both a normative and strategic foundation for digital repositories. Elements such as institutional regulations, the adoption of open access principles, and the implementation of the FAIR framework play a central role in establishing the legitimacy of repositories within academic systems (Gómez & Bernal, 2023; Puspita et al., 2024). However, governance should not be viewed merely as a set of formal rules. It also serves as a guiding mechanism that shapes how repositories are integrated into systems of academic accountability, research performance evaluation, and long-term institutional strategy. In many developing contexts, weak alignment between national and institutional policies results in repositories that operate at a functional level but lack transformative impact. The absence of standardized evaluation metrics further complicates efforts to assess their contribution to research quality and scientific visibility.

The technological infrastructure dimension provides the operational basis for repository sustainability. An architecture that is interoperable, secure, and scalable is essential to ensure long-term data integrity and accessibility (AbouZaid et al., 2025; Singh & Gupta, 2022). The adoption of open standards such as OAI-PMH, the use of open-source platforms, and the integration of artificial intelligence demonstrate the ongoing evolution of repository systems in response to technological developments. Nevertheless, technology alone does not determine effectiveness. Even advanced infrastructure will have a limited impact without supportive governance and sufficient organizational capacity. In this sense, technology acts as an enabler whose value depends on its alignment with other institutional dimensions.

The institutional and human resource dimension highlights that repositories are not only technical systems, but also organizational practices that rely on structural support and collaborative culture. The competencies of repository managers, including technical expertise, managerial capability, and digital leadership, are crucial in aligning system operations with institutional strategic goals (Taddese et al., 2025; Bougoulia & Glykas, 2023). Without effective coordination across units, such as libraries, IT divisions, academic offices, and data centers, repositories risk becoming fragmented and losing their integrative function. In the Indonesian context, the limited availability of professionals with expertise in metadata, digital curation, and open science principles underscores the importance of strengthening human capacity. The emergence of roles such as digital librarians and metadata specialists further reflects the recognition of repositories as a distinct professional domain within knowledge governance.

The user service and experience dimension positions repositories as interactive spaces connecting systems with academic communities. A user-centered approach has been shown to enhance participation and support the sustained use of repositories (Ikwuanusi et al., 2023; Lake & Regenauer, 2024). Features such as advanced search capabilities, accessibility for users with diverse needs, feedback mechanisms, and integration with academic profiles contribute to the practical value of repositories for researchers and faculty members. Without a clear service orientation, repositories risk remaining underutilized despite their availability. Therefore, user experience should be treated not as a complementary aspect, but as a core component in both the design and evaluation of repository systems.

These four dimensions are inherently interconnected and mutually reinforcing. Policies that are well-designed but lack adequate infrastructure may fail to implement, while sophisticated technologies without institutional capacity or user orientation may lack strategic relevance. Similarly, capable human resources operating without a clear governance framework may struggle to optimize

repository functions. For this reason, digital repositories should be understood as integrated systems that require alignment across governance, technology, organizational capacity, and user experience within a management framework that is both sustainable and responsive to the evolving landscape of open science.

#### **4.2 The Relationship Between Digital Repositories and Institutional Knowledge Management**

Digital repositories are no longer just storage spaces for research outputs. They are increasingly becoming part of institutional knowledge management structures. In higher education and research contexts, repositories serve as nodes connecting processes such as knowledge acquisition, organization, storage, curation, and dissemination. Through this role, repositories link academic knowledge production with decision-making, innovation, and ongoing institutional learning.

From a digital knowledge management perspective, repositories enable institutions to turn explicit knowledge into organizational assets that are documented, traceable, and reusable. Studies show that effective digital knowledge management can improve efficiency and help institutions remain resilient in times of change (Gupta et al., 2023). This suggests that repositories are not only tools for storing information but also systems that support reflection, policy evaluation, and evidence-based decision-making.

The role of repositories within knowledge infrastructure has also shifted over time. They are no longer seen as supporting technical units, but as core components of institutional information ecosystems (Narlock et al., 2024). In practice, repositories are connected to organizational learning and academic performance management. They serve as spaces to collect research outputs, document learning activities, and provide data for analyzing trends and mapping institutional strengths. This shift shows that repositories operate at both epistemic and managerial levels.

An evaluative perspective helps explain how repositories are positioned within institutions. Models of knowledge management maturity suggest that effectiveness depends on the alignment of technology, institutional structures, and organizational culture (Bougoulia & Glykas, 2023). In this sense, repositories can be seen as indicators of an institution's maturity in managing knowledge. The more integrated repositories are into planning and evaluation processes, the stronger the institution's ability to use knowledge strategically.

The practical relevance of repositories becomes clearer when linked to sustainable development agendas. Through structured metadata practices, repositories can help map research contributions to frameworks such as the Sustainable Development Goals (SDGs) (Nel et al., 2024). This means repositories are not only about documentation but also about demonstrating and legitimizing academic contributions in broader contexts. Their role therefore extends beyond technical functions into more strategic and normative domains.

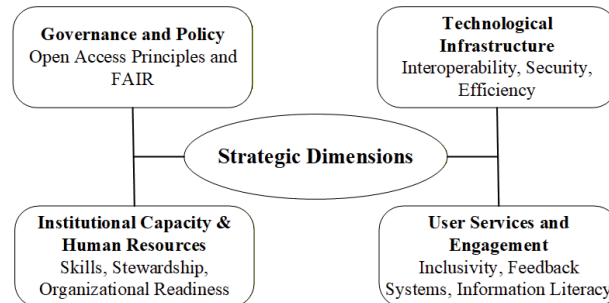
Across the knowledge life cycle, repositories play a continuous role—from research planning to publication and ultimately to the use of research outputs in policy or social innovation. When integrated with academic systems, research databases, and performance evaluation platforms, repositories create a more continuous flow of information. This enables institutions to learn, monitor research impact, and identify areas needing further development.

However, this kind of integration does not happen automatically. In many cases, issues persist, including fragmented policies, limited incentives for self-archiving, and varying levels of information literacy among users. Without consistent support and a collaborative culture, repositories may exist but are not fully used in practice.

For this reason, repositories need to be positioned as part of broader institutional strategies that are planned and sustained over time. Aligning governance, organizational structures, human

resources, and digital technology is essential. Otherwise, repositories will remain documentation tools rather than becoming part of an institution's adaptive capacity to build a more inclusive and collaborative knowledge ecosystem.

Figure 1 illustrates how repositories serve as nodes within institutional knowledge management systems, linking information flows, curation processes, and knowledge dissemination to research agendas and broader development goals.



**Figure 1.** Digital Repositories in the Institutional Knowledge Management System

Source: Author's elaboration based on literature review (2025)

### 4.3 Conceptual Model of Repositories as Knowledge Infrastructure

Drawing on literature from multiple fields—such as information science, knowledge management, digital technology, and higher education policy—this study develops a conceptual model of digital repositories as part of the knowledge infrastructure. The model is not a rigid or prescriptive framework but an analytical lens for understanding how different elements interact. It brings together four main dimensions discussed earlier: governance and policy, technological infrastructure, institutional capacity and human resources, and user services. These dimensions are treated as interconnected components that shape how repositories are managed within higher education and research institutions.

In this model, digital repositories are not merely seen as places to store research outputs. They are positioned as key nodes within the broader cycle of knowledge production, curation, dissemination, and use. The relationships among the four dimensions are not linear or hierarchical but dynamic and mutually influencing. Changes in one dimension can affect the others, sometimes in subtle ways. Because of this, a systemic perspective is important. It helps understand repository management in relation to organizational complexity, including how policies, operational practices, and user interactions are connected.

Within this framework, governance and policy serve as a foundational layer, both normatively and strategically. Policies on open access, FAIR compliance, and alignment with broader open science agendas help define the direction and legitimacy of repositories (Puspita et al., 2024; Gómez & Bernal, 2023; UNESCO, 2021). At the same time, governance is not only about formal rules. It also involves how responsibilities are distributed, how decisions are made, and how institutions respond to evolving regulatory and technological environments. In this sense, governance serves as a coordinating mechanism that helps keep institutional goals, user needs, and technological capacity aligned.

The technological infrastructure dimension provides a digital framework that ensures interoperability, security, scalability, and efficiency in managing scientific data. The use of cloud-native architectures, such as data lakehouses, enables more flexible and integrated cross-system data management (AbouZaid et al., 2025). In addition, protection systems against cyber threats are prerequisites for maintaining the integrity and sustainability of academic data (Singh & Gupta, 2022). Furthermore, configuring knowledge infrastructure underscores that the success of technology

adoption depends not only on technical sophistication but also on alignment among system design, institutional policies, and everyday work practices (Andersson, 2023). Therefore, in this model, technology is positioned as a strategic enabler whose effectiveness depends heavily on alignment with governance and organizational capacity dimensions.

The institutional capacity and human resources dimension is a pillar of long-term repository management strategies. Data stewardship practices, particularly for multidisciplinary and artificial intelligence-based data, require high levels of curatorial and ethical competence (Taddese et al., 2025). This underscores that repositories are professional domains requiring specialized expertise, not merely additional administrative tasks. In this model, institutional capacity includes the ability of organizations to build adaptive teams, provide continuous training, develop professional competency standards, and create clear career pathways for repository managers. Without a strong human capacity foundation, investment in policy and technology will be difficult to translate into sustainable impact.

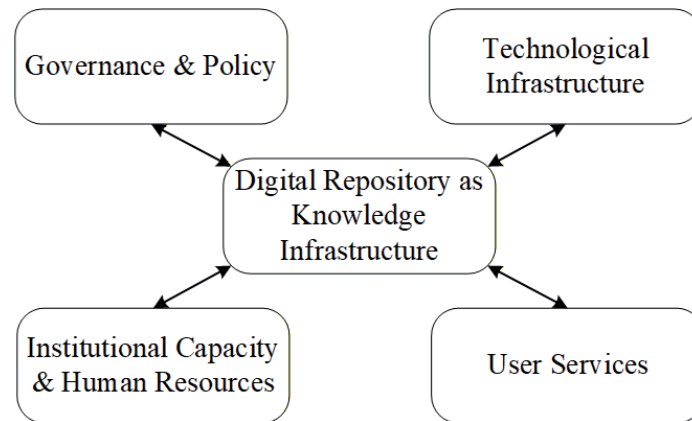
The user service and experience dimension serves as a link between repositories and their users, both within academic settings and the wider public. When repository design aligns with user needs, it tends to encourage higher participation, better compliance with self-archiving practices, and greater reuse of research outputs (Ikwanusi et al., 2023). Ongoing feedback also plays an important role, particularly in maintaining metadata quality and keeping content relevant over time (Lake & Regenauer, 2024). In this model, user experience is not treated as an additional feature but as a core element that shapes how repositories are used in academic practice. Repositories that adopt a user-centered approach are generally better able to respond to the needs of different groups, such as faculty, researchers, students, and even the broader public, through accessible design, intuitive interfaces, and attention to inclusivity.

At a broader level, the model positions the four dimensions as interconnected and mutually reinforcing. Improvements in governance can support more consistent technology implementation, while stronger human resource capacity can lead to more effective system use. Likewise, better user services can increase participation, which in turn contributes to richer repository content. Conversely, weaknesses in one area can affect the overall balance of the system. This highlights that digital repositories, when viewed as knowledge infrastructure, cannot be managed in isolation or through fragmented approaches but require coordination across multiple dimensions.

**Table 2.** Relationships Among Dimensions in the Conceptual Model

| Dimension                                  | Role in the Repository System                                                                                  | Relationship with Other Dimensions                                                                                                    | Management Implications                                                                                |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| Governance and policy                      | Provides regulatory framework, operational standards, and strategic direction for repository management        | Directs technological infrastructure development, determines institutional resource allocation, and establishes user service policies | Strengthening repository policies, integration with research and open publication policies             |
| Technological infrastructure               | Provides digital platform for storage, curation, and dissemination of knowledge                                | Supports implementation of repository policies, facilitates repository management work, and provides access services for users        | Development of interoperable systems, data security, and integration with academic information systems |
| Institutional capacity and human resources | Manages repository operations through technical competence, metadata curation, and organizational coordination | Implements repository policies, operates technological infrastructure, and develops user-based services                               | Training of repository managers, strengthening the roles of digital librarians and metadata managers   |
| User services and experience               | Provides access, navigation, and knowledge utilization for academic communities and the public                 | Utilizes technological infrastructure, guided by repository policies, and maintained by repository managers                           | Development of user-centered features, improvement of accessibility, and support for self-archiving    |

The relationships among these dimensions are illustrated in the conceptual model of digital repositories as knowledge infrastructure (see Figure 2). The model offers a way to understand repositories not only as technical systems but also as part of a broader framework oriented toward sustainability, collaboration, and adaptability within institutional knowledge management. Through this perspective, institutions can better evaluate the position of their repositories and design improvement strategies that account for the dynamic interactions among these dimensions.



**Figure 2.** Conceptual Model of Digital Repository Management as Knowledge Infrastructure

Source: Author's elaboration based on literature review (2025)

#### 4.4 Implications of the Model and Directions for Strengthening Institutional Repositories

The conceptual model of digital repositories as knowledge infrastructure developed in this study has several theoretical and strategic implications. From a conceptual standpoint, the model broadens how repositories are understood. Rather than being seen only as storage systems or tools for open access, repositories are framed as interconnected systems that integrate governance, technological infrastructure, institutional capacity, and user services. This perspective suggests that repositories should not be examined in isolation. Instead, they need to be understood as part of a broader, evolving institutional knowledge management architecture that responds to changes in policy, technology, and academic practices.

From a theoretical perspective, the model's main contribution is highlighting the interdependence among these dimensions. Much of the existing literature still examines repositories through separate lenses—whether technical, policy-related, or institutional. In contrast, this model shows that repository effectiveness depends on how these elements are configured and aligned. In doing so, it offers a more integrated analytical approach for studying institutional repositories, particularly in developing contexts where resource constraints and fragmented policies remain significant challenges.

At the strategic level, the model indicates that efforts to strengthen repositories need to move beyond isolated initiatives and adopt a cross-functional, systemic approach. In terms of governance, this means embedding repository-related policies within key institutional documents, such as research master plans, open publication policies, and faculty performance evaluation systems. Without this integration, repositories risk being treated as standalone technical projects with limited strategic impact. Strengthening internal regulations, aligning them with national frameworks, and developing clear performance indicators are therefore important initial steps.

From a technological perspective, strengthening efforts should focus on improving interoperability, ensuring data security, and supporting long-term scalability. Integrating repositories with academic information systems, research databases, and reporting platforms can help create a more connected

and sustainable data ecosystem. This also implies that technological investment should not be limited to periodic system upgrades. Institutions need to pay attention to the overall system architecture, particularly to enable data exchange across different institutional and sectoral contexts.

Third, strengthening institutional capacity and human resources is an important prerequisite for the sustainability of the model. Institutions need to develop competency standards for repository managers and provide ongoing training. In addition, professional career pathways in digital information management need to be more clearly defined. In this context, strategic leadership plays an important role in ensuring cross-unit coordination, adequate budgeting, and the development of an organizational culture that supports open science practices and knowledge collaboration.

Fourth, an orientation toward services and user experience must be integrated into institutional strategy. These services cannot be treated solely as technical aspects of system interface design. Repositories that are responsive to the needs of faculty, researchers, students, and external stakeholders will achieve higher levels of participation and sustainability. Therefore, developing user-centered features, feedback mechanisms, and consultative services, such as repository clinics or self-archiving assistance, is a relevant direction for strengthening.

More broadly, this model also creates opportunities for repositories to serve as instruments of advocacy and the legitimization of academic contributions to sustainable development agendas. Through systematic metadata management and integration with global indicators such as the Sustainable Development Goals (SDGs), repositories can strengthen the position of institutions within national and international research networks. This shows that repositories do not only function as internal infrastructure but also as bridges between knowledge production and institutional social responsibility.

Although the model offers an integrative perspective, it remains conceptual in nature. As such, further validation through empirical studies across diverse institutional contexts is still needed. Approaches such as case studies, institutional surveys, or evaluations based on performance indicators could provide a deeper understanding of how repositories function in practice. This line of future research is essential to ensure that the model is not only theoretically sound but also relevant and applicable in real-world settings.

For this reason, efforts to strengthen institutional repositories should not be limited to technological upgrades or administrative compliance. A more systemic approach is needed—one that integrates policy development, organizational capacity building, user-oriented service design, and consistent strategic leadership. In addition, the effectiveness of repositories is closely linked to the levels of information and digital literacy within the academic community. Information literacy helps users assess the quality of scientific sources, while digital literacy enables them to access, manage, and share knowledge effectively through repository platforms. With this integrated approach, digital repositories have the potential to become a key foundation for building a more open, collaborative, and sustainable knowledge ecosystem.

## 5. CONCLUSION

Digital repositories have become an important part of knowledge infrastructure in the open access era. Drawing on a conceptual literature review of 39 articles published between 2021 and 2025, this study shows that repository effectiveness cannot be explained by a single factor. Instead, it is shaped by the interaction of four main dimensions: governance and policy, technological infrastructure, institutional capacity and human resources, and user services. These dimensions work together as a system that influences how repositories function and their sustainability within institutional knowledge management.

The findings suggest that well-functioning repositories are not defined solely by reliable storage systems. They also depend on alignment across several aspects, including supportive institutional policies, interoperable and secure technologies, competent managers, and services that respond to user needs. The model developed in this study shows that these dimensions are interconnected and continuously influence one another. In this sense, repositories are better understood as governance-based knowledge infrastructure rather than merely technical tools for storing academic outputs.

At the same time, the study indicates that repository practices in many institutions remain fragmented and often remain technically oriented. Integration with knowledge management systems and long-term institutional strategies is not yet fully achieved. Gaps among policy, technology, and organizational capacity can limit repositories' ability to serve as tools for coordination and academic accountability. Additional challenges, such as weak cross-unit coordination, limited long-term funding, and varying levels of digital literacy, further complicate repository development in practice.

Based on these findings, several strategic directions can be considered. Strengthening governance should involve embedding repositories in research policies, performance evaluation systems, and open publication strategies, supported by consistent implementation of FAIR principles and open science. Technological development should focus on interoperability, cybersecurity, and sustainable data architecture. At the same time, institutions should invest in human resource development through training in digital literacy, metadata management, and open data practices, and provide clearer professional roles for repository managers. A stronger user-centered approach is also needed, particularly by improving accessibility and feedback mechanisms. At a broader level, coordination and policy alignment across institutions remain important for sustaining repository ecosystems.

Finally, because the proposed model is conceptual, further empirical research is needed to test its applicability across diverse institutional contexts. Case studies, surveys, and the development of measurement tools grounded in the four dimensions could help refine and validate the model. With a more integrated approach that links policy, technology, organizational capacity, and user engagement, digital repositories have the potential to play a more central role in shaping open, collaborative, and sustainable knowledge ecosystems at both national and global levels.

## **DECLARATIONS**

### **Data Availability**

The literature review dataset and supporting materials used in this study are publicly available in the RIN Dataverse repository at: <https://hdl.handle.net/20.500.12690/RIN/FQTE3L>

### **CRedit (Contributor Roles Taxonomy)**

Conceptualization, Methodology, Writing – Original Draft, and Writing – Review & Editing: Author.

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### **Competing Interest**

The author declares that there are no competing interests.

### **The use of AI or AI-assisted technologies**

The author confirms that AI-assisted tools were used only for language refinement, while all conceptual development and analysis were conducted independently.

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