Maghreb Journal of Historical and Social Studies - Sidi Bel-Abbes University
ISNN : 2170-0060 EISSN : 2602-523X
Volume 17 -- Issue 01 -- June 2025 P 644 - 660

Algerian Institutional Repositories in the Cloud Era: Opportunities and Challenges

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DOI :

Received: 11 /04/2025 **Accepted: 12 /06/2025** **Published: 19/06/2025**

Abstract:

This study highlights the context of Algerian institutional repositories in the cloud era, exploring the current state of Algerian institutional repositories and discussing the principal differences between traditional institutional repositories and cloud-native repositories. This paper highlights the opportunities , challenges, and the application considerations for Algerian institutions considering cloud migration for their repositories such as infrastructure evaluation, data security protection and cost challenges. In addition of the international best practices of implementing cloud computing technology into institutional repositories. And concluding by some recommendation for a more significant Algerian higher education sector.

Keywords: cloud computing technology ; institutional repositories; Digital preservation; Cloud migration.

1. Introduction:

In recent years, and with the rapid changes in the digital and technological environment, massive scholarly outputs require Resilient preservation infrastructures and effective preservation strategies which are essential for ensuring long-term access to digital content.

Synchronously, cloud computing technology was introduced as a scalable solution for digital preservation. It keeps excelling in the role of a

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technology that enables users to access computing resources and services from anywhere, at any time, via the internet. (Guechidoun, 2024)

Accordingly, this article examines Algerian institutional repositories leveraging cloud computing technology, highlighting its potential for scalable storage, cost-effectiveness, accessibility, and collaborative creation. It spotlights opportunities such as resource integration, preservation, and democratization of access to scholarly output.

On the other hand, it also confronts with obstacles such as security and Data Protection Issues, Ongoing Financial Costs, Local Policies and Laws. Eventually, This study provides strategic recommendations for developing resilient, open, and user-centered cloud repositories.

2. Problematic:

Cloud computing, with its ability to place large datasets and massive computational resources in close proximity, seems to offer an ideal solution to these problems. However, there are many different possible ways to organize and structure cloud computing for data-driven science. (Ryan P. Abernathey, 2021)

In the same way, Algerian institutions are implementing cloud computing technology for scalable, cost-effective, and easily accessible digital infrastructure, particularly in sectors like education, research, and public administration, enhancing cooperation and data security.

Regardless of cloud computing technology capabilities that makes it a powerful modern tool for institutions such as Scalability and Elasticity, Data Storage and Backup. its operational deployment in Algerian institutional repositories is impeded by risks such as cost and payment challenges, privacy and digital security concerns and Connectivity & Infrastructure Gaps. Addressing these challenges requires well-considered strategies to maximize the benefits of cloud computing without compromising service quality. (Guechidoun, 2024)

Building upon the previous points, the importance of examining institutional repositories in the cloud era and the opportunities this technology delivers is a central focus of this article and its fully highlighted. As a result, the following question emerges: What technical, legal, and infrastructural challenges do Algerian universities face in adopting cloud-based repositories?, What are the main opportunities offered by cloud computing for institutional repositories in the Algerian higher education context?.

3. Methodology:

This study implemented a descriptive-analytical approach through the use of:

- Exploring previous studies related to our research topic.
- Collecting and evaluating insights about cloud computing technology and Algerian institutional repositories
- Exploring international best practices in the application of cloud computing technology and institutional repositories
- Shedding light on the practical challenges and strategic opportunities that come with this digital shift.
- Concluding with best practices for cloud adoption in academic contexts while addressing the specific requirements of institutional repositories as scholarly information systems.

4. Study objectives:

1. Evaluate the current state of institutional repositories in Algerian academic and research institutions.
2. Discuss the role and significance of cloud computing technology in the context of institutional repositories.
3. Examine leading experiences in employing cloud computing in institutional repositories.
4. Explore the challenges and barriers to cloud adoption for institutional repositories in Algeria.
5. Implement recommendations for Algerian institutions considering cloud migration for their repositories.

1. Cloud computing as an important output of digital technologies*:*

1.1 cloud computing technology definition:

It is defined by the National Center for Standards and Technology (NIST) as a model that provides rapid and appropriate access at anytime and anywhere permanently to a shared network of computing resources, for example networks, servers, applications, storage and services. (mell & grance, 2011).

In other words it refers to "the delivery of computing as a service rather than a product, whereby shared resources, software, and information are provided to computers and other devices as a metered service over a

network, typically the internet". According to the National Institute of Standards and Technology, it is a system where you can easily access and use these resources whenever you need them without much hassle or needing to interact a lot with the service provider.

1.2 The Role of Cloud Computing in the context of digital transformation:

As cloud computing continues to evolve, ensuring strong data security remains a critical challenge. Traditional security methods often fall short against emerging threats such as data breaches and unauthorized access. Advancements in encryption, access control, and AI-driven anomaly detection have enhanced cloud security, improving data confidentiality and integrity. Implementing multi-layered security frameworks and compliance-driven strategies strengthens protection against cyber threats. This paper examines innovative approaches to securing cloud environments, addressing key vulnerabilities, and optimizing data protection measures. (basha, rishik, & krishna, 2023)

Digital transformation is a vital step to ensure that libraries remain information and knowledge centers in the modern digital world. Libraries can provide more diverse and efficient services to their users by adopting digital technologies and cloud computing, as the latter allows libraries to store vast amounts of data on cloud servers accessible via the internet. (Guechidoun,2024)

Many Algerian universities are thinking about adopting cloud computing but they are facing some problems in relation to standardize software, administrative procedures, budget constraints, connectivity issue. (pandya, 2014)

1. Institutional repositories in Algerian universities:

In today's digital era, Cloud Computing technology has become an important solution for efficient data storage and management. Advantages such as scalability, flexibility of access, and reduced cost of information technology infrastructure make Cloud Computing increasingly in demand by various sectors including health and finance (Alemami et al., 2023)

1.1 Definition of institutional repositories (IRs):

An institutional repository represents a digital collection that captures, preserves, and distributes the intellectual output of a university or research

institution while providing open access to institutional research output. (abrizah, noorhidawati, & kiran, 2023)
"Institutional repositories are digital archives that collect, preserve, and disseminate the intellectual output of an institution, particularly a research institution." (shen, 2022)

1.2 What is the difference between cloud-native data repositories and institutional repositories (IRs) ?

The fundamental architectural distinction lies in how these systems address infrastructure management, with cloud-native repositories abstracting away the underlying hardware concerns while traditional IRs are more tightly coupled to institutional IT systems.

Table1. a comparison between Cloud-Native Data Repositories and Traditional Institutional Repositories based on performance, cost, accessibility, and other key factors drawn from the study context.

Criteria	Cloud-Native Data Repositories	Traditional Institutional Repositories (IRs)
Performance	Scalable computing resources overcome storage, I/O, and CPU bottlenecks.	Limited by local hardware capacity; performance bottlenecks are common.
Reliability	Reliability burden is shifted to cloud providers; benefits from industry-level infrastructure.	Dependent on institution-maintained servers; may crash under high load.
Cost-Effectiveness	Avoids data duplication; supports on-demand computing and cost-sharing architecture.	Same datasets often stored repeatedly; inefficient use of local resources.
Collaboration	Global namespace (e.g., URLs) enables seamless code and data sharing.	Collaboration hampered by local filesystem dependencies and inconsistent file structures.
Reproducibility	Supports open, reproducible workflows by integrating with cloud tools (e.g., Binder).	Local dependencies hinder reproducibility of research and data analysis.

Creativity	Enables flexible exploration of new datasets and directions.	Constrained by only pre-downloaded, pre-cleaned datasets.
Downstream Impacts	Facilitates data use by businesses and startups operating in the cloud.	Less compatible with modern commercial/cloud-based data workflows.
Access & Inclusion	Reduces hardware and bandwidth requirements; promotes inclusion globally.	Assumes access to powerful local workstations and high-speed internet.
Social Objectives	Enables collaboration, inclusion, and reproducibility.	Struggles to support broader social goals due to infrastructure limitations.
Comparison to HPC	Public cloud platforms better support openness and social objectives.	HPC offers strong performance but limited access and less focus on collaboration/inclusion.

Source: prepared by the authors extracted from (Ryan P. Abernathey, 2021)

2.3 the current state of Algerian institutional repositories:

Table2. Algerian institutional repositories extracted from open doar

Repository name	Type	Software	status/url
Abdelhamid Mehri University Constantine2 Scholarlyworks Repository	Institutional	DSpace	**Non-functional** http://dspace.univ-constantine2.dz
Bibliothèque Centrale	Institutional	DSpace	**Functional** http://bibliotheque.univ-batna.dz/
Bibliothèque Virtuelle de l'université d'Alger	Institutional	DSpace	**Functional** http://biblio.univ-alger.dz/jspui/
CRTI Digital Library	Institutional	Other	**Functional** https://library.crti.dz/
Center of Academic Publications	Institutional	Other (wordpress)	**Functional** https://www.univ-soukahras.dz/en/publication

Cerist Digital Library	Institutional	Dspace	**Functional** https://dl.cerist.dz/home
Dspace CREAD	Institutional	Dspace	**Non-functional** http://dspace.cread.dz:8080/jspui/
Dépôt Institutionnel de l'Université M'Hamed Bougara de Boumerdes	Institutional	Dspace	**Non-functional** http://dlibrary.univ-boumerdes.dz:8080/jspui
Dépôt institutionnel de l'université Frères Mentouri Constantine 1	Institutional	Dspace	**Non-functional** http://depot.umc.edu.dz
dspace@UABT	Institutional	DSpace	**Functional** http://dspace.univ-tlemcen.dz/
Entrepôt Numérique de l'Université d'Alger 2	Institutional	DSpace	**Non-functional** http://193.194.83.152:8080/xmlui
Mohamed Boudiaf University of M'Sila Repository	Institutional	DSpace	**Non-functional** http://dspace.univ-msila.dz:8080/xmlui/
Repository of Hassiba Benbouali of Chlef	Institutional	DSpace	**functional** http://dspace.univ-chlef.dz/
Repository of Oran 2 University Mohamed Ben Ahmed	Institutional	DSpace	**Functional** https://ds.univ-oran2.dz:8443/
USTHB repository	Institutional	DSpace	**Non-functional** https://repository.usthb.dz
University Ferhat Abbas Sétif 1 Repository	Institutional	DSpace	**Functional** http://dspace.univ-setif.dz
University of Biskra Theses	Institutional	Eprints	**Functional** http://thesis.univ-biskra.dz/

Repository			
University of Biskra repository	Institutional	DSpace	**Functional** http://archives.univ-biskra.dz/
University of Eloued DSpace	Institutional	DSpace	**Functional** http://dspace.univ-eloued.dz/

Source: Prepared by the researchers.

Table3. Analysis of Functional Algerian institutional Repositories:

status	**count**	**percentage**
Functional	**12**	**63,15%**
Non-functional	**7**	**36,85%**
Total Indexed	**19**	**100%**

Source: Prepared by the researchers.

From the above tables we can say that Seven of the links of these institutional repositories are not reachable to the public use because of Internet Protocol problems (IP). The other twelve institutional repositories are reachable. The current state of Algerian institutional repositories marks the lack of cloud computing technology integration. Regardless of the rapid evolution of digital resource management and the global shift towards scalable, flexible cloud infrastructures, Numerous Algerian repositories persist in use conventional, locally hosted formats. Consequently, Algerian higher education institutions may be lacking essential benefits provided by cloud-native solutions, such as augmented resource sharing, enhanced data accessibility, and strong support for research reproducibility, highlighting the urgent necessity for strategic modernization in this sector.

2. Best practices, Opportunities and challenges of implementing cloud computing technology in Algerian institutional repositories:

2.1 best practices of the application of cloud computing in IRs:

Open institutional digital repositories provide free access to articles, research and other forms of intellectual production for the members of the institutions that applied this technology, There are many successful projects

for open digital repositories that have contributed greatly to the building of the knowledge society. Such as open DOAR which is a part of the Sherpa Project and the British Library, the project primarily focuses on articles that have been accepted for publication, the project enables academic institutions in Britain that do not have institutional repository, as well as the researchers who are not affiliated with a particular institution.

- **The Global Context of Institutional Repositories:**

Institutional repositories (IRs) have become essential components of academic infrastructure worldwide, here are the best practices of the implementation of cloud computing technology in the institutional repositories across the world.

- **The European Open Science Cloud (EOSC) Synergy Project**, launched with €8.5 million in funding, Implemented a federated network of cloud services in 10 European states. Managed by the Spanish National Research Council, the project contains upwards of 42 million scholarly records from more than 200 academic repositories. . Key success factors include standardized APIs, distributed storage, European PID infrastructure, and integration with domain-specific data services. Initial performance metrics showed a 215% increase in cross-border data reuse and a 67% reduction in duplicate dataset storage. (González-Aranda et al., 2023)
- **Open AIRE MAKE**: a non-profit, has taken over Zenodo, a successful cloud-native repository platform, from CERN in 2022. The platform now uses a hybrid cloud model, enabling it to scale to over 3 million research outputs and maintain 99.98% uptime. Recent enhancements include AI-powered content classification, automated metadata, integration with 40 journal submission systems, and enhanced visualization tools.

- **The University of California's California Digital Library (CDL):** utilizes Amazon S3 for scalable storage of digital archives. This setup allows the CDL to manage a growing collection of digital resources without worrying about physical server limitations**.**
- **The University of Cambridge - DSpace with Amazon Web Services (AWS) Implementation:** The University of Cambridge employs Amazon Web Services (AWS) to host its DSpace institutional repository, offering scalable and economical cloud

storage for its extensive digital content collection. The university utilizes AWS to facilitate the expansion of their repository without incurring costly infrastructure enhancements.
Cloud Instruments Utilized AWS S3 for file storage, EC2 for compute, and RDS for managing metadata and additional repository data.
This technology enables the University of Cambridge to efficiently augment its repository's storage capacity and manage substantial volumes of digital content without sacrificing performance or availability.

- **Implementation of Google Cloud at the University of Toronto Libraries:** The University of Toronto Libraries employ Google Cloud for the storage and management of digital assets within their institutional repository. They have transitioned essential components of their digital preservation infrastructure to the cloud, facilitating enhanced scalability and greater access to research materials.
Cloud Technologies Utilized Google Cloud Storage for data storage, Big Query for analytics, and Cloud Pub/Sub for inter-system messaging. The implementation of cloud technology has afforded the University of Toronto a more dependable, secure, and scalable infrastructure for the storage and dissemination of digital content, alongside enhanced capabilities for efficient usage data analysis.
- **Harvard University Cloud-Based Digital Preservation Implementation:** Harvard University employs cloud-based solutions in its digital preservation strategy for its institutional repository, utilizing Amazon Web Services (AWS) for cloud storage and disaster recovery. The transition to the cloud enables Harvard to concentrate on its primary objective of delivering access to high-quality,sustainably protected data.
Utilized Cloud Tools: Amazon S3 for storage, AWS Elastic Load Balancing (ELB) for traffic management, and AWS Backup for automated backup administration.
Impact: By utilizing cloud computing, Harvard guarantees that digital content is safely kept, readily accessible, and backed up to assure sustained access for future generations.

- **Japanese Institutional Repositories Online (JAIRO) Cloud:** Japan's National Institute of Informatics has developed JAIRO

Cloud, a cloud-based repository infrastructure for 811 academic institutions. The service offers customizable interfaces, integration with Japan's HPCI, native support for research data management, and enhanced bilingual metadata handling.

In addition, The National Institute of Informatics (NII) in Japan plays a crucial role in enhancing open access to scholarly resources through its innovative initiative, JAIRO Cloud. This cloud computing facility serves as a centralized platform for institutional repositories, enabling universities to share and disseminate research outputs effectively. By collaborating with university libraries, NII has successfully promoted the digitalization of scholarly materials, particularly doctoral dissertations, in alignment with government mandates. The adoption of WEKO as the repository software streamlines operations, encouraging smaller institutions to participate and fostering a community of shared expertise. The overarching aim of these efforts is to cultivate a culture of open access in Japan and across Asia, thereby transforming scholarly communication and enhancing the global knowledge base. This initiative not only addresses immediate educational needs but also sets the foundation for a sustainable future in academic publishing and research dissemination. (Adachi, 2014)

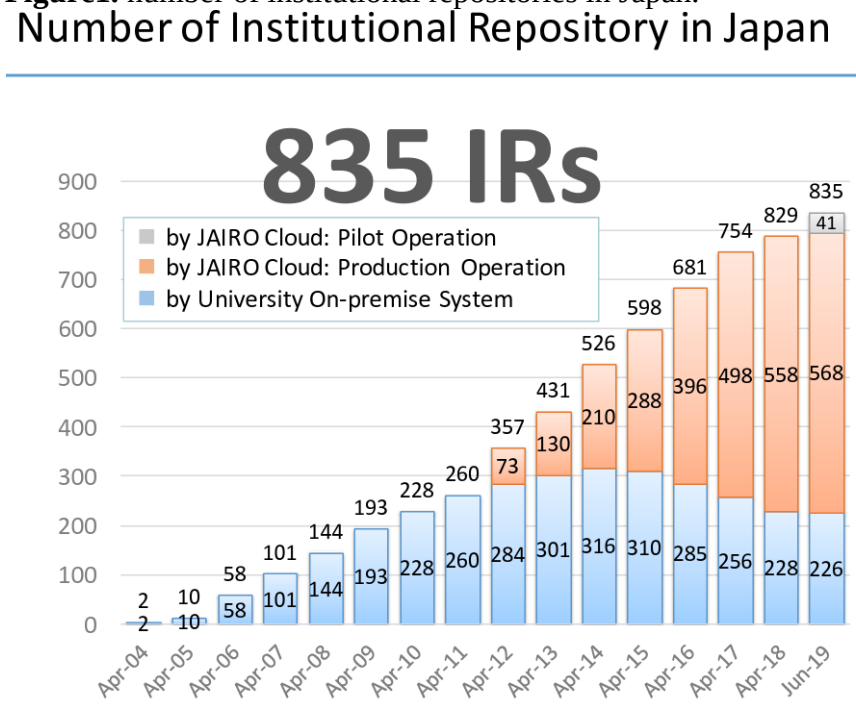
The next challenge is to encourage the development of a university-wide OA mandate—a policy that is not yet implemented at any university in Japan. In addition, there is a need to integrate JAIRO Cloud more deeply into library and research workflows, making it an essential infrastructure component in support of research. Furthermore, the experience gained from delivering this service can pave the way for future initiatives that emphasize rich content and research data alongside pure textual repositories.

Feel free to adjust further as needed! (adachi, 2014)

JAIRO Cloud's recent "Next Generation" upgrade (completed in 2023) Implemented a range of innovative approaches:

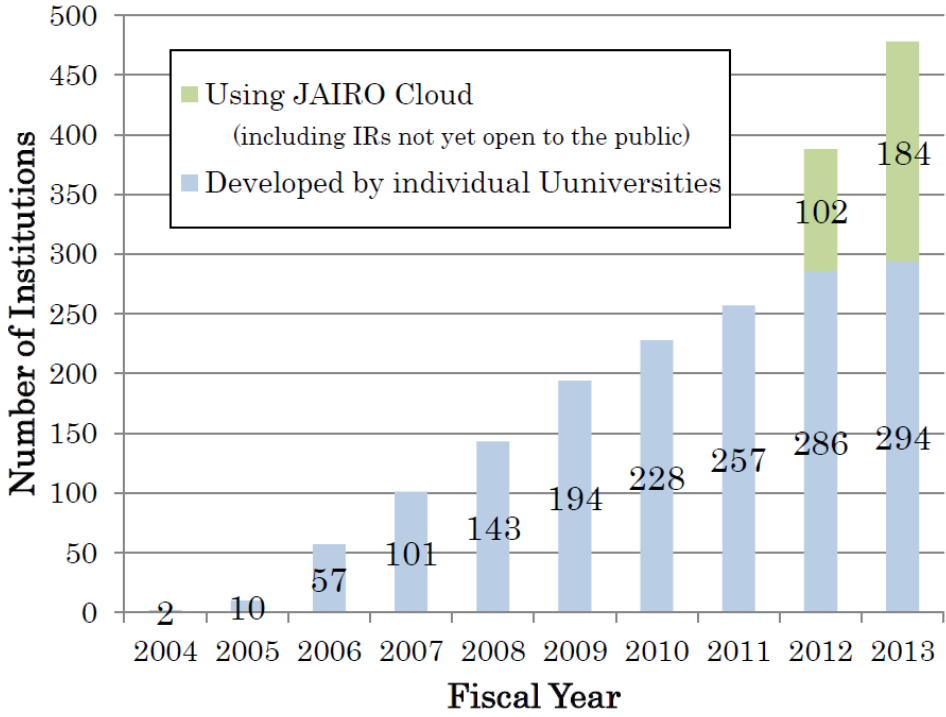
Overall, the review of the previous study underscores that The next challenge is to promote a university-wide open access mandate and integrate JAIRO Cloud into library and research workflows, aiming to make it an integral infrastructure component for research support.

Figure1. number of institutional repositories in Japan.



Source. (yamaji, 2020)

Figure1. Content Type stored in Japanese Institutional Repositories from 2004-2013



Source: (Adachi, 2014).

The figure depicts the increasing utilization of institutional repositories (IRs) by Japanese institutions over a decade (2004–2013). The blue bars illustrate the number of Institutional Research units established by each universities, commencing at just 2 in 2004 and progressively rising to 294 by 2013. This progressive increase indicates the significance that Japanese academic institutions attribute to the preservation and dissemination of intellectual output in an open-access format. As IR technologies advanced, numerous institutions acknowledged the importance of systematically documenting and disseminating their faculty's research, hence promoting a collaborative academic atmosphere.

A significant trend illustrated in the image is the adoption of JAIRC Cloud (green bars), commencing with 102 in 2012 and increasing to 184 in 2013. JAIRC Cloud (Japan Institutional Repository Cloud) offers a communal

infrastructure for institutions that may be deficient in resources or technical expertise to autonomously administer their own repositories. The provision of a cloud-based platform reduces entrance barriers and standardizes repository procedures among universities, enhancing interoperability, adherence to metadata standards, and the discoverability of research results. The adoption of JAIRC Cloud highlights a strategic initiative for cost-sharing and sustainable digital scholarship support in Japan's higher education sector.

This visual data highlights that by 2013, the majority of Japanese institutions have either established their own repositories or embraced the cloud-based option. This trend corresponds with global initiatives advocating open science and highlights the significance of institutional repositories in facilitating information dissemination. The success of JAIRC Cloud exemplifies how collaborative approaches can accelerate institutional engagement in open access, thereby reinforcing Japan's dedication to widespread and equitable research dissemination.

Figure3. JAIRO cloud fee

Number of organization researchers	JPCOAR membership fee(JPY)*	JAIRO Cloud service fee(JPY including TAX)	Total cost (JPY including TAX)
0 – 100	20,000	43,200	63,200
101-200	20,000	86,400	106,400
201-300	20,000	129,600	149,600
301-400	20,000	172,800	192,800
401-500	20,000	216,000	236,00
501-600	20,000	259,200	279,200
601-700	40,000	302,400	342,400
701-800	40,000	345,600	385,600
801-900	40,000	388,800	428,800
901-1000	40,000	432,000	472,000
1001-1100	40,000	475,200	515,200
1101-1200	60,000	518,400	578,400
1201-1300	60,000	561,600	621,600
1301-1400	60,000	604,800	664,800
1401-1500	60,000	648,000	708,000
1501-	60,000	691,200	751,200

*If an institution requires to use JAIRO Cloud service, the institution should join JPCOAR with paying membership fee.

Source: (Adachi, 2014).

1.1 Cloud Computing technology as a Strategic Solution for Algerian IRs

Cloud computing, with its ability to place large datasets and massive computational resources in close proximity, seems to offer an ideal solution to these problems. However, there are many different possible ways to organize and structure cloud computing for data-driven science. Proprietary platforms, like Google Earth Engine (Gorelick, 2017). (are one-stop-shop solutions that provide both data and computing. They are powerful but generally controlled by a single company, with limited flexibility and modularity. In contrast, open architectures assume data will be distributed over the Internet and seek interoperability between different data catalogs and computational tools. (Beaujardière,2019) We contend that open architectures are the best path forward for big-data scientific infrastructure.

Cloud computing offers a significant economic benefit, By understanding the economic benefits and challenges of cloud computing, institutions can determine whether CC is a suitable technology for their specific needs and how it can help them achieve their business objectives. A report by the International Data Corporation (IDC) found that the economic benefits of cloud computing extend beyond cost savings. The report highlights that this technology can enable organizations to innovate more quickly, improve customer service, and increase employee productivity.

1.2 Challenges of practicing cloud computing technology in IRs

- Cloud-native data repositories have the potential to accelerate scientific discovery, but they face challenges such as funding, structural factors, and aggregation. Academic research institutions and funding systems are not used to paying for cloud computing, and potential cost savings can only be realized by aggregating research groups. Overcoming these challenges may require long-term investments and funding support.
- Cloud-native data repositories science workflows require user education and training, as experienced users must unlearn familiar patterns and learn new concepts. Distributed computing tools like Dask require new training, and university and lab IT staff may feel confused by elastic scaling and serverless computing. Coordinated efforts are needed to realize cloud computing's potential for science.

- Cloud-native data repositories face challenges in data access and privacy, especially in fields like climate science and astronomy. Without flexible tools for access control, privacy concerns may lead to proprietary solutions. Technical development and agency funding are needed to extend approaches for managing access to less open datasets.

Conclusion:

Despite these challenges, we continue to be highly motivated that Algerian institutions have the potential of implementing cloud computing technology as a solution to transform scientific research in data-intensive fields in Algeria. We hope that, by helping to define best practices for cloud-native data repositories, we have made a small contribution toward building the infrastructure we need to tackle the some of the great scientific challenges of the future in the Algerian higher education.

Algerian institutions need to consider a serious shift from traditional institutional repositories to cloud-based repositories, these recommendations are based upon global best practices and current trends in cloud computing technology:

- Algerian institutions should outline a clear and strategic framework for digital transformation that clearly incorporates the shift toward cloud-based repository systems and improved communication facilitated by cloud solutions, learning from the development international examples explained above such as Jairo cloud Japanese experience.
- Formulate Supportive Policies and Guidelines: It is essential to implement institutional open access (OA) guidelines and associated policies that promote cloud usage. Ensuring data security should be a key part of these regulations. with current research procedures. By conforming to international standards established by the National Institute of Standards and Technology (NIST), Algerian institutions can guarantee that their cloud-based systems fulfill stringent security and interoperability criteria.
- Invest in Infrastructure and Capacity Building: Transitioning to cloud-based repositories requires investment not only in technology but also in human capital Algerian institutions should prioritize staff training in cloud technologies and digital repository management and preservation . Moreover, leveraging

cloud service providers to host institutional repositories can mitigate the challenges related to local infrastructure constraints while providing reliable, scalable solutions.

- using end-to-end encryption in improving data security in Cloud Computing environments: The implementation of end-to-end encryption (E2EE) in Cloud Computing serves as one of the main methods in protecting data from various threats, be it data leakage, unauthorized access, or cyber-attacks. This encryption works by encrypting data before it leaves the user's device and decrypting it only at the authorized receiving device, ensuring that only authorized parties can access the data (Sinha, 2023). Thus, E2EE encryption lowers the chance for third parties, including cloud service providers or hackers, to access data that is being moved or stored. Prior to the implementation of encryption, data in Cloud Computing was often vulnerable to information leakage.

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