Library Progress International *Print version ISSN 0970 1052*
Vol.44 No.3, Jul-Dec 2024: P.4703-4710 *Online version ISSN 2320 317X*

Original Article *Available online at www.bpasjournals.com*

The Future of Information Science: Exploring the Role of Libraries In Data Management and Digital Curation

Dr. Nilima Paul[1*]

[1*]Librarian, Mrinalini Datta Mahavidyapith, Birati, Kol-51, (Affiliated to West Bengal State University)
nilimapaul96@gmail.com

How to cite this article: Nilima Paul (2024). The Future of Information Science: Exploring the Role of Libraries in Data Management and Digital Curation. *Library Progress International,* 44(3), 4703-4710.

Abstract
Libraries are no longer confined to their traditional formats and are now in the process of becoming the heart of data and digital preservation. This change is critical for research, digital preservation, and open data initiatives. This paper will seek to discuss the existing and possible role of libraries with an emphasis on data management and digital preservation. In this respect, it provides an overview of new developments, challenges, and prospects for libraries in the context of digital scholarship and RDM. As expected from the review of literature and case studies from academic and research libraries, the review also centers on the practical use of emerging technologies like AI and blockchain in managing data by the libraries. Today's libraries are repositories of information, educators of data, and advocates of open data. Some of the trends that are transforming library services now are Artificial Intelligence, Cloud Computing, Blockchain etc. However, there are some challenges that libraries face, for instance, technological obsolescence, lack of funds, and the need to renew professional development. Libraries hold the future of information science since they are in charge of data collection and storage. Thus, there are certain challenges that libraries encounter to remain relevant in the knowledge society and information management with the development of technology.

Keywords: Artificial Intelligence, Blockchain Technology, Data Management, Digital Curation, Digital Libraries, Digital Preservation, Information Science

1. Introduction

Information science being an interdisciplinary science is concerned with the acquisition, organization, storage, retrieval, and dissemination of information (Zins, 2007). This has come about as a result of the need to handle vast information and knowledge across disciplines and sub-disciplines of library science computer science and cognitive science. Information science is mainly aimed at making the data and knowledge available and useful to the users to the required degree. Information science has evolved particularly with the adoption of digital technologies. These have altered how information is processed, stored, and also accessed making the field very relevant in today's digital and data-driven society. Because of the availability of big data, artificial intelligence, and the internet, the handling and filtering of a vast amount of information is relevant. In this regard, the need for libraries becomes crucial to change regarding new trends and tools to preserve information in digital forms.

There are even libraries that are establishments that contain books and other printed materials to lend to the user which have also evolved with the help of technology. With technology such as the internet, digitalization, and cloud storage, the operations of the library have become more of a digital library (Fabunmi et al., 2006). This is in concordance with the shift from the physical to the digital collections hence making it possible for the libraries to meet the demands of the users from all over the world (Li Liew, 2014). The transformation that has taken place in several libraries where they have been turned into hybrid or fully digital libraries has resulted in the development of digital libraries which are libraries that contain texts, multimedia, and datasets (Jinendra Jain & Kumar Behera, 2023). Contemporary libraries are not only the

buildings where people come to read or to borrow books but also the places that work as the centers of information and knowledge which enhance the utilization of modern technologies for the needs of the clients (Leckie & Hopkins, 2002). The current day information society requires librarians to be in charge of purchasing electronic resources, training users on information literacy, and identifying large volumes of electronic information. Libraries have also incorporated cloud computing, online databases, and automation to enhance their functionality. Digital libraries have been noticed to grow in the 21st century and the shift towards open access has been observed to be on the rise thus improving the dissemination of knowledge (Witten et al., 2009). This has also seen the incorporation of artificial intelligence and machine learning when it comes to the cataloging of the services offered to the users, and this is a new concept in libraries. Due to the digital conversion of data, the amount of data created, gathered, and used has grown significantly, and therefore, data management and digital stewardship are factors that are current in libraries (Deja et al., 2021). Data management can be defined as processes and resources that ensure data and information are available, accurate, and protected throughout their originated life span right from the time when it was created up to the time when they were disposed of (Xu et al., 2022). As institutions that hold past and current data, there is a challenge to archive and make available this information in a way that can meet the increasing demand for research, learning, and the public. Second, data management leads to improved quality of data, its accessibility, and utilization and this is important when it comes to digital preservation in modern society. Digital curation is the act of selecting, organizing, maintaining, and preserving digital content (Beagrie, 2008). It implies that digital assets are well-managed and accessible in times of need to enhance the sustainable management of information (Wong & Chiu, 2024). In the process of migrating to digital curation, more libraries are ready to solve issues from technology and the depreciation of data formats. Also, the curation process has its benefits because it also determines the quality, authenticity, and relevance of the data which is so important for the researchers who deal with digital materials. This has shown that libraries play a more active role in the management of research data, metadata, and institutional repositories (Yu, 2017). Thus the role of libraries in data administration and digital curation becomes even more critical. According to the above points, it can be argued that by applying proper data management libraries can work on enhancing partnerships for academics, research, and in the knowledge economy. Finally, the last is the influence of the management and curation of data in library services that will define the future of information science and the position of the library as a stakeholder in research and learning (Virkus & Garoufallou, 2020).

2. The Role of Libraries in Data Management

Data management in libraries can be defined as the process of obtaining data, processing, storing, archiving, and disseminating data (Krier & Strasser, 2014). The shift in the transformation of libraries is from being organizations that are associated with books alone to being associated with digital and research data. This shift is because the quantity and compactness of data in the present world is much higher than before and they need to be handled. Library data management can be explained as the process of managing the library data that is produced by the library as well as the data that may be produced by other research or community projects. For instance, as pointed out by Tenopir et al. (2014), libraries have found ways and means of procuring tools and know-how to be prepared to handle data as well as guarantee that such data is of quality and relevance in the future. In this new paradigm, libraries have positioned them as info and institutional data depositories. This stewardship function is the ensuring of the context in which data is maintained and adherence to the metadata standard and other practices in use in digital preservation. Institutional repositories of libraries in various institutions including academic institutions have data archives that contain important research products for future use for replication purposes. According to Corrall et al. (2013), the stewardship that libraries undertake enhances the responsibility and accountability of research activities especially those concerning big data fields. An example of the practical application of a library function in the management of data is the advocacy for data literacies. The above efforts are meant to improve the proficiency of the researchers, students, and the public in comprehending, interpreting, and applying data. It is possible to identify that libraries enable data literacy in an organization by providing opportunities for workshops, online resources, and collaboration with academic departments (Koltay, 2017). Therefore, as libraries meet the contemporary needs of their users and help in the task of increasing data literacy in society, they offer such programs as part of their services. Yet another role that is espoused by libraries is in the promotion of open data initiatives which is a concept that entails data sharing with the public (Shepherd et al., 2019). Open data is therefore vital in the formation of partnership, innovation, and accountability in research. Libraries also are usually the keepers of institutional repositories that contain open data in the framework of open science and open government data. Libraries are engaged in RDM through the services they provide to assist researchers in managing data, during its life cycle and in sharing,

as well as archiving (Al-Jaradat, 2021). These are supported by libraries containing information on how to create metadata, the legal side, and the technical context of RDM.

3. Digital Curation in Libraries

Digital curation may be defined as the process of acquiring, organizing, preserving, and promoting digital objects throughout their life cycle (Yakel, 2007). This is a crucial process for libraries, especially at a time when they are transitioning from managing a few digital objects to managing a large number of research data, institutional records, and digitized documents. The goal of digital curation is to make sure that the future generation will be able to read and use the knowledge that has been produced in the cultural and scientific fields in a format that is resistant to technological progress (Kowalczyk, 2018). In the context of libraries, digital curation ensures that the digital assets are going to be usable and comprehensible in the future which is why it helps institutions to achieve their mission to provide access to information in the future. This is because there is more and more content generated and there should be best practices for handling digital information. As libraries are expanding their responsibilities for managing data, digital stewardship is the way through which libraries ensure the integrity and accessibility of both native digital and digitized materials (Xie & Matusiak, 2016). It is therefore important to note that the best practices for digital preservation are the proactive management of risks that are associated with data loss and obsolescence. Some of these practices are audit, migration, and compliance with standards such as the Open Archival Information System (OAIS) Reference Model (Lee, 2010). The models used by these libraries ensure that the digital content is protected and can always be recovered irrespective of the change in the hardware or the software (ISO 14721:2012) (Rosa, 2017). Preservation standards like METS (Metadata Encoding and Transmission Standard) and PREMIS (Preservation Metadata: The other elements of Digital Curation are also referred to as Implementation Strategies They provide frameworks for documenting the life cycle of digital assets, metadata that facilitates the management, preservation and integrity of digital collections (Caplan, 2009). Through these standards, libraries make sure that the digital resources are operable on other systems and platforms, which is critical for the sustainability of the resources.

3.1 Challenges in Digital Curation and the Role of Librarians

There are some challenges that digital curation presents that affect the way libraries operate and assist in the preservation of digital resources. Technological obsolescence, whereby the formats or the storage media on which data is stored become obsolete and it becomes difficult to read the data is a big risk. This is a problem that libraries have to continuously adapt in their structures and strategies to address. Metadata management is also a problem as it contributes to the lack of consistency in resources' identification and their availability in the future. Digital objects are best described by metadata schemes that are responsive to the characteristics of the objects and the context in which they are placed (Kallinikos et al., 2010). In addition, because of the lack of funding, libraries are unable to provide the technical and human resources needed for digital curation. The issue of funding is one of the issues that can affect the development of large-scale preservation plans. Other challenges are also connected with security since libraries have to safeguard digitized materials from cyber threats (Xiong & Wang, 2024). All these challenges are well handled by the librarians. They are involved in the identification, classification, archiving, and dissemination of digital materials, collaborating with other professionals like IT professionals, statisticians, etc., in the stewardship of digital resources. They also help in developing policies on digital preservation and help institutions in the right approach to adopt digital preservation through their understanding of metadata standards and digital archiving. In this regard, librarians have to ensure that they are conversant with technological advancement and the best practices in digital curation to enable their institutions to achieve the best in digital preservation (Higgins, 2013).

4. Emerging Trends in Library Data Management

In the context of the new paradigm of information science, libraries are facing deep transformations in the ways of data handling. One of the trends that has been observed is the metadata-driven approaches which are popular in the current world. Metadata role is also coming out as another important concern for libraries to enhance cataloging, discoverability, and integration with external data sources (Han & Hswe, 2011). Linked open data (LOD) is also being implemented in libraries to enhance compatibility by linking library resources to global reference structures (Candela et al., 2022). This shift is in line with the general trend of openness and linking of information which is in line with the current trend of libraries to provide open access to research outputs. The other type of system is the collaborative data management system. These platforms allow several parties including academic institutions, government agencies and private organizations to store, manage, and analyze data within one system. Such systems assist in the reduction of

the development of disparate data storage systems and assist in the development of knowledge integration systems (Golub, 2021).

4.1 Use of Artificial Intelligence & Machine Learning in Data Management

AI and ML are now considered new approaches in the management of library data, which assist libraries in enhancing data management, user engagement, and operations. It can be useful in categorizing large volumes of digital assets, a process that is less likely to be done incorrectly as compared to when it is done manually (Das & Islam, 2021). Recommendation systems are also being created by employing machine learning algorithms that anticipate the behavior of the users and offer them recommendations which is an added value to the user interface and they tend to spend more time on the digital resources (Khanal et al., 2020). In addition, NLP tools are helping libraries expand their search possibilities by determining the meaning of the search terms (Ali et al., 2020). Through deep learning, the libraries can analyze the big data and find patterns that are helpful in research exercises. AI and ML are also applied in data preservation in which predictive models are used to assess the rate of degradation of physical and digital records to ensure that information is retrievable in the future (Das et al., 2022).

4.2 The Blockchain for Secure Data Transactions and Archiving

Blockchain technology is slowly finding its place as a new standard in how libraries manage secure data, especially in the realms of transactions and records. Blockchain has the capability of creating a digital record that can record and verify digital transactions, which makes it possible to protect data and ensure that digital assets are genuine (Bralic et al., 2020). Blockchain can be beneficial in libraries that store vital research data or users' data since it is extremely difficult to change the recorded data (Zaabar et al., 2021). Moreover, blockchain technology provides the opportunity to develop smart contracts that can facilitate and enforce the agreements between libraries and their users or between libraries and vendors. This automation is useful in cutting down the paperwork and is also clear and answerable. In digital archiving, blockchain ensures the records' authenticity as it provides an immutable record which is crucial in the storage of academic and research data (Galiev, 2018).

4.3 Cloud computing and Virtual repositories in Libraries

Cloud computing has brought a lot of changes in the way libraries manage, store, and share digital resources. Other related benefits that libraries are also able to enjoy when they migrate their data storage to cloud-based platforms are IaaS, PaaS, and SaaS since it is cheaper, more flexible, and has better security (Gibson et al., 2012). Cloud platforms also assist libraries in offering online repositories that can be accessed by researchers, students, and the public at their convenient time and place. Libraries that have adopted the concept of virtual repositories have access to centralized data management systems which are appropriate for large storage and sharing. These repositories offer a plausible solution to the ever-expanding collections of e-books, journals, and multimedia resources while offering patrons and researchers real-time access to the resources (Loan, 2014). Moreover, there is an emerging adoption of hybrid cloud solutions which allow the library to use both the public and private cloud services to improve the flexibility of the cloud services while at the same time ensuring the privacy of the sensitive data.

4.4 Digital Libraries for Big Data and Research Outputs

The concept of big data has permeated academic research and this has influenced library practices in several ways for instance many institutions have established digital repositories to manage large volumes of research outputs. These repositories serve as libraries where research data are deposited, preserved, and made accessible to other users in the world (Xu et al., 2022). Big data management requires the use of systems that are capable of handling large data, and at the same time ensuring that the data quality is maintained and that the data will be useful in future research (Garoufallou & Gaitanou, 2021). They are also used in the promotion of open-access publishing where authors are free to publish their works without restrictions of the normal publishing models. Such repositories are often located in libraries that collaborate with academic journals and funding agencies to fulfill the data-sharing policies. It also makes knowledge accessible to the public and fosters innovation since it allows knowledge from different fields to be shared.

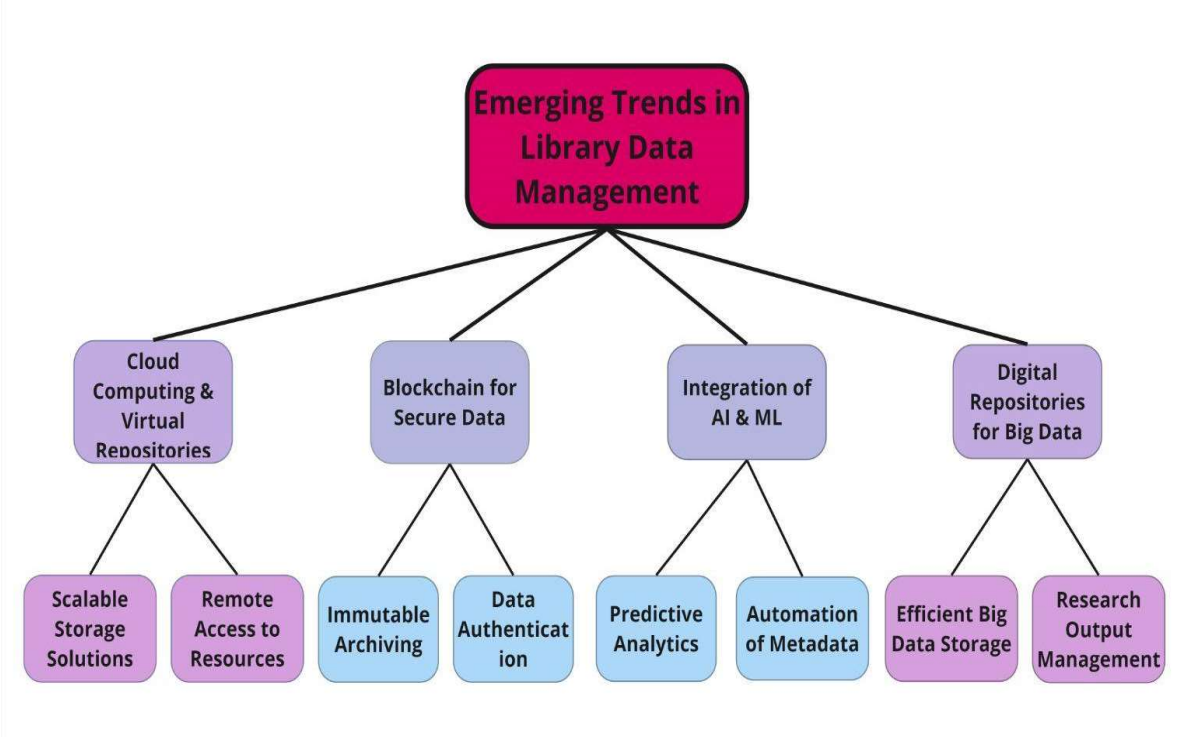

Fig 1: Emerging Trends in Library Data Management

5. Challenges in Data Management and Digital Curation

Some of the important issues that come into discussion in the light of data management and digital curation in libraries are as below. Some of the challenges include; technological restraints and financial restraints because most libraries cannot afford to upgrade to new technologies such as data storage and analysis. The costs of new technologies and infrastructure changes are high and hurt the institutions' budgets (Andrikopoulou et al., 2022). However, privacy, security, and data ownership questions make the process of dealing with digital assets even more challenging. Libraries are a place where they need to shield the users' information from hacking while at the same time dealing with issues of data ownership and data sharing especially in an open-access environment (Wessels et al., 2014). Another challenge is the issue of human capital where there is a shortage of skilled human capital in the area of library; most of the current qualified librarians are still in the process of developing the skills of managing digital assets. This gap makes it necessary for one to be on par with the existing technology and practice through consistent professional development (Cox & Pinfield, 2014). Furthermore, another factor that defines the level of difficulty is the extent to which cultural and historical data are kept. Some of the challenges that libraries face include the following; how to ensure that important digital resources are retained for the long term since storage space is a scarce commodity and how to ensure that institutional practices are standardized (Khan, 2023). The solutions to these problems are imperative so that libraries can control and develop their digital assets.

6. The Role of Collaboration in Enhancing Data Management

Consequently, there is a fundamental shift in libraries to fulfill the needs of data and digital object management which demand cross-sectoral collaboration. Today, universities, research centers, data scientists, technological firms, and International organizations are involving the libraries to improve data management. Jahnke et al. (2012) also observe that universities have been identified to possess comparatively poor data storage and management policies and procedures and data sharing frameworks. These collaborations assist the libraries in the formation of institutional repositories for archiving data for the long term and also for cross-disciplinary use. Libraries also help the researchers to meet data management policies such as the FAIR principles which enhance the access and reproducibility of the data (Wilkinson et al., 2016). This is important as it engages data scientists and technology firms as these offer technical expertise in handling big and complicated data. Engagements with these scholars help in the creation of complex systems of data management such as metadata and cloud storage. Libraries can therefore be able to regulate the data and its utilization while at the same time embracing modern-day innovations such as machine learning (Mane, 2024). There is a need for international cooperation in setting standards and

policies for data, and therefore, data must be available as well as compliant in the world. Currently, there are global organizations such as the Research Data Alliance (RDA) and the International Council for Science (ICSU) that prescribe how data should be managed (Kim, 2020). This is supported by the understanding that libraries have in the making of metadata as well as digital preservation. The roles of libraries are changing from the shelving and archiving of books to the purchasing and archiving of e-journals, datasets, and digital repositories thus promoting the sharing of information and cross-disciplinary research. They also endorse open access, data ethics, and open science and are therefore vital to digital scholarship and ethical research (Corrall et al., 2013; Akers et al., 2014; Bezuidenhout et al., 2017).

7. Conclusion

Nevertheless, libraries are at present right in the middle of the evolving image of information science and are already involved in data processing and archiving. It is however pertinent to state that libraries have not been left behind in the current digital world as they have transitioned from being storehouses of physical resources to storehouses of digital resources, research data, and open data. Their tasks such as data stewardship, teaching data literacy, and promoting responsible data use all evidence of the growing role of libraries in an academic and research environment. Some of the new technologies that are altering the way libraries manage data include; artificial intelligence, machine learning, blockchain, cloud computing, and so on. They enhance the facility of information retrieval, security, and storage thus enabling the libraries to extend better services to the researchers and the public. However, the fast-changing technology brings in problems such as obsolescence, lack of adequate capital to support the new technology, and training of personnel. Further, with the increase in the volume of data, there are questions concerning access, privacy, and the proper conduct in the use of data in libraries especially with the introduction of open data. However, libraries are in good stead to determine the future of information science. They are important in the knowledge economy because of their capability in indexing, archiving, and retrieving knowledge. With the changing dynamics of libraries in this century information age management of data and digital content for research, learning, and innovation is likely to be more important in the future. Some of the future trends in respect of libraries include the following; it is important to involve technology vendors and universities, they should consider human capital investment, and adopt new technologies. In this way, they will be able to keep offering the core services required for the advancement of open science, accurate data, and sharing of knowledge in the online environment.

References

1. Akers, K. G., Sferdean, F. C., Nicholls, N. H., & Green, J. A. (2014). Building support for research data management: Biographies of eight research universities. *International journal of digital curation*, *9*(2), 171-191. https://doi.org/10.2218/ijdc.v9i2.327
2. Ali, M. Y., Naeem, S. B., & Bhatti, R. (2020). Artificial intelligence tools and perspectives of university librarians: An overview. *Business Information Review*, *37*(3), 116-124. https://doi.org/10.1177/0266382120952016
3. Al-Jaradat, O. M. (2021). Research data management (RDM) in Jordanian public university libraries: Present status, challenges and future perspectives. *The Journal of Academic Librarianship*, *47*(5), 102378. https://doi.org/10.1016/j.acalib.2021.102378
4. Andrikopoulou, A., Rowley, J., & Walton, G. (2022). Research data management (RDM) and the evolving identity of academic libraries and librarians: A literature review. *New Review of Academic Librarianship*, *28*(4), 349-365. https://doi.org/10.1080/13614533.2021.1964549
5. Beagrie, N. (2008). Digital curation for science, digital libraries, and individuals. *International Journal of Digital Curation*, 1(1). https://doi.org/10.2218/ijdc.v1i1.2
6. Bezuidenhout, L. M., Leonelli, S., Kelly, A. H., &Rappert, B. (2017). Beyond the digital divide: Towards a situated approach to open data. *Science and Public Policy*, *44*(4), 464-475. https://doi.org/10.1093/scipol/scw036
7. Bralić, V., Stančić, H., & Stengård, M. (2020). A blockchain approach to digital archiving: digital signature certification chain preservation. *Records Management Journal*, *30*(3), 345-362. https://doi.org/10.1108/RMJ-08-2019-0043
8. Candela, G., Escobar, P., Carrasco, R. C., & Marco-Such, M. (2022). Evaluating the quality of linked open data in digital libraries. *Journal of Information Science*, *48*(1), 21-43. https://doi.org/10.1177/0165551520930951
9. Caplan, P. (2009, December). Understanding Premis. Washington DC, USA: Library of Congress.

10. Corrall, S., Kennan, M. A., & Afzal, W. (2013). Bibliometrics and research data management services: Emerging trends in library support for research. *Library trends*, *61*(3), 636-674. https://doi.org/10.1353/lib.2013.0005
11. Cox, A. M., & Pinfield, S. (2014). Research data management and libraries: Current activities and future priorities. *Journal of librarianship and information science*, *46*(4), 299-316. https://doi.org/10.1177/0961000613492542
12. Das, B. R., Maringanti, H. B., & Dash, N. S. (2022). Role of artificial intelligence in preservation of culture and heritage. In *Digitalization of Culture through Technology* (pp. 92-97). Routledge.
13. Das, R. K., & Islam, M. S. U. (2021). Application of artificial intelligence and machine learning in libraries: a systematic review. *arXiv preprint arXiv:2112.04573*. https://doi.org/10.48550/arXiv.2112.04573
14. Deja, M., Rak, D., & Bell, B. (2021). Digital transformation readiness: perspectives on academia and library outcomes in information literacy. *The Journal of Academic Librarianship*, *47*(5), 102403. https://doi.org/10.1016/j.acalib.2021.102403
15. Fabunmi, B. A., Paris, M., & Fabunmi, M. (2006). Digitization of library resources: Challenges and implications for policy and planning.
16. Galiev, A., Prokopyev, N., Ishmukhametov, S., Stolov, E., Latypov, R., & Vlasov, I. (2018, October). Archain: A novel blockchain based archival system. In *2018 Second World Conference on Smart Trends in Systems, Security and Sustainability (WorldS4)* (pp. 84-89). IEEE. https://doi.org/10.1109/WorldS4.2018.8611607
17. Garoufallou, E., & Gaitanou, P. (2021). Big data: opportunities and challenges in libraries, a systematic literature review. *College & Research Libraries*, *82*(3), 410.
18. Gibson, J., Rondeau, R., Eveleigh, D., & Tan, Q. (2012, November). Benefits and challenges of three cloud computing service models. In *2012 Fourth International Conference on Computational Aspects of Social Networks (CASoN)* (pp. 198-205). IEEE. https://doi.org/10.1109/CASoN.2012.6412402
19. Golub, K. (2021). Automated subject indexing: An overview. *Cataloging & Classification Quarterly*, *59*(8), 702-719. https://doi.org/10.1080/01639374.2021.2012311
20. Han, M. J., & Hswe, P. (2011). The evolving role of the metadata librarian. *Library Resources & Technical Services*, *54*(3), 129-141. https://doi.org/10.5860/lrts.54n3.129
21. Higgins, S. (2013, March). Digital curation: the challenge driving convergence across memory institutions. In *The memory of the world in the digital age: digitization and preservation: an international conference on permanent access to digital documentary heritage, Vancouver, Canada, 26-28 September 2012* (pp. 607-623). United Nations Educational, Scientific and Cultural Organization.
22. Jahnke, L., Asher, A., & Keralis, S. D. (2012). The problem of data.
23. Jinendran Jain, S., & Kumar Behera, P. (2023). Visualizing the academic library of the future based on collections, spaces, technologies, and services. *International Journal of Information Science and Management (IJISM)*, *21*(1), 219-243. https://doi.org/10.22034/ijism.2023.700794
24. Kallinikos, J., Aaltonen, A., & Marton, A. (2010). A Theory of Digital Objects. *First Monday*, *15*(6-7). https://doi.org/10.5210/fm.v15i6.3033
25. Khan, A. S. (2023). The Preservation of Cultural Heritage: Challenges and Opportunities In the Digital Age. *Al-Behishat Research Archive*, *1*(01), 16-24.
26. Khanal, S. S., Prasad, P. W. C., Alsadoon, A., & Maag, A. (2020). A systematic review: machine learning based recommendation systems for e-learning. *Education and Information Technologies*, *25*(4), 2635-2664.https://doi.org/10.1007/s10639-019-10063-9
27. Kim, S. (2020). Machine-actionable data management plans model analysis and improvement direction. *Journal of Information Science Theory and Practice*, *8*(4), 20-28. https://doi.org/10.1633/JISTaP.2020.8.4.2
28. Koltay, T. (2017). Data literacy for researchers and data librarians. *Journal of Librarianship and Information Science*, *49*(1), 3-14. https://doi.org/10.1177/0961000615616450
29. Kowalczyk, S. T. (2018). *Digital curation for libraries and archives*. Bloomsbury Publishing USA.
30. Krier, L., & Strasser, C. A. (2014). *Data management for libraries: a LITA guide*. American Library Association.
31. Leckie, G. J., & Hopkins, J. (2002). The public place of central libraries: Findings from Toronto and Vancouver. *The Library Quarterly*, *72*(3), 326-372.
32. Lee, C. A. (2010). Open archival information system (OAIS) reference model. *Encyclopedia of library and information Sciences*, *3*, 4020-4030.
33. Li Liew, C. (2014). Towards dynamic and evolving digital libraries. *The Electronic Library*, *32* (1), 2-16. https://doi.org/10.1108/EL-07-2012-0089

34. Loan, F. A. (2014). Open access digital repositories in Asia: Current status and future prospects. *International Journal of Information Science and Management (IJISM)*, *12*(2), 35-45.
35. Mane, D. (2024). Cloud-Based Solutions for Enhanced Catalog Management in University Libraries. *Library Progress International*, *44*(1), 35-50.
36. Rosa, C. A. L. S. (2017). *Strategies for Digital Preservation of Information* (Master's thesis, Instituto Politecnico de Leiria (Portugal)).
37. Shepherd, E., Bunn, J., Flinn, A., Lomas, E., Sexton, A., Brimble, S., ... & Page, J. (2019). Open government data: critical information management perspectives. *Records Management Journal*, *29*(1/2), 152-167. https://doi.org/10.1108/RMJ-08-2018-0023
38. Tenopir, C., Sandusky, R. J., Allard, S., & Birch, B. (2014). Research data management services in academic research libraries and perceptions of librarians. *Library & Information Science Research*, *36*(2), 84-90. https://doi.org/10.1016/j.lisr.2013.11.003
39. Virkus, S., & Garoufallou, E. (2020). Data science and its relationship to library and information science: a content analysis. *Data Technologies and Applications*, *54*(5), 643-663. https://doi.org/10.1108/DTA-07-2020-0167
40. Wessels, B., Finn, R. L., Linde, P., Mazzetti, P., Nativi, S., Riley, S., ... & Wyatt, S. (2014). Issues in the development of open access to research data. *Prometheus*, *32*(1), 49-66. https://doi.org/10.1080/08109028.2014.956505
41. Wilkinson, M. D., Dumontier, M., Aalbersberg, I. J., Appleton, G., Axton, M., Baak, A., & Mons, B. (2016). The FAIR Guiding principles for scientific data management and stewardship. *Scientific data*, *3*(1), 1-9. https://doi.org/10.1038/sdata.2016.18
42. Witten, I. H., Bainbridge, D., & Nichols, D. M. (2009). *How to build a digital library*. Morgan Kaufmann.
43. Wong, A. K. K., & Chiu, D. K. (2024). Digital curation practices on web and social media archiving in libraries and archives. *Journal of Librarianship and Information Science*, 09610006241252661. https://doi.org/10.1177/09610006241252661
44. Xie, I., & Matusiak, K. (2016). *Discover digital libraries: Theory and practice*. Elsevier.
45. Xiong, J., & Wang, X. (2024). Library data protection and threat detection system based on network security. *International Journal of Information and Computer Security*, *24*(1-2), 137-153. https://doi.org/10.1504/IJICS.2024.140212
46. Xu, Z. (2022). Research data management practice in academic libraries. *Journal of Librarianship and Scholarly Communication*, *10*(1). https://doi.org/10.31274/jlsc.13700
47. Xu, Z., Zhou, X., Kogut, A., & Watts, J. (2022). A scoping review: Synthesizing evidence on data management instruction in academic libraries. *The Journal of Academic Librarianship*, *48*(3), 102508. https://doi.org/10.1016/j.acalib.2022.102508
48. Yakel, E. (2007). Digital curation. *OCLC Systems & Services: International digital library perspectives*, *23*(4), 335-340. https://doi.org/10.1108/10650750710831466
49. Yu, H. H. (2017). The role of academic libraries in research data service (RDS) provision: Opportunities and challenges. *The Electronic Library*, *35*(4), 783-797. https://doi.org/10.1108/EL-10-2016-0233
50. Zaabar, B., Cheikhrouhou, O., Jamil, F., Ammi, M., & Abid, M. (2021). Health Block: A secure blockchain-based healthcare data management system. *Computer Networks*, *200*, 108500. https://doi.org/10.1016/j.comnet.2021.108500
51. Zins, C. (2007). Conceptions of information science. *Journal of the American Society for Information Science and Technology*, *58*(3), 335-350. https://doi.org/10.1002/asi.20507