

Digital Transformation of Academic Libraries Using AI-Powered Electronic Resource Services

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Abstract

Academic libraries are changing dramatically these days. They're no longer just quiet buildings filled with dusty books they've become dynamic hubs where researchers can access electronic resources and get help managing their data. This paper looks at how this shift is playing out in Tamil Nadu, specifically examining how university libraries there are handling research data management and electronic resources like e-journals, e-books, online databases, and institutional repositories. I've drawn on fifteen recent Tamil research studies to understand the current situation. What I found is a mixed picture. On the one hand, Tamil Nadu's academic libraries have made real strides in acquiring electronic resources and making them available to users. On the other hand, there are still major gaps in infrastructure, in digital skills, and in the policies needed to support effective research data management. Library professionals are wrestling with some tough challenges. How do you manage collection development when so much is moving online? How do you get researchers to actually use the electronic resources you've invested in? And how do you build the kind of data management support that researchers increasingly need?

The good news is that there are strategies that work. Better training, stronger collaboration between libraries, and smarter use of technology can all make a difference. But it's going to take sustained effort from library professionals, institutional leadership, and policymakers to really move the needle. This article wraps up with some practical recommendations for strengthening research data management, getting more value out of electronic resources, and building a culture where data-driven research thrives in Tamil Nadu's academic institutions.

Keywords: Research Data Management, Electronic Resources, Academic Libraries, Tamil Nadu, Digital Libraries, Institutional Repositories, Information Literacy

1. Introduction

Academic libraries serve as the intellectual backbone of higher education institutions, providing essential resources and services that support teaching, learning, and research. In recent decades, the rapid advancement of information and communication technologies has fundamentally reshaped the nature of

library collections and services. The traditional model of academic libraries as repositories of print materials has given way to a hybrid environment where electronic resources—including e-journals, e-books, online databases, and digital repositories—have become increasingly central to library operations (Murugan, 2023).

The emergence of electronic resources has revolutionized the way researchers access and utilize information. Electronic resources offer numerous advantages over traditional print materials, including 24/7 accessibility, remote access capabilities, rapid search and retrieval, and the ability to access multiple resources simultaneously. These resources have become indispensable tools for studying, learning, and conducting research in the digital age.

Concurrently, the growing emphasis on research productivity and the increasing volume of research data generated by academic institutions have brought research data management (RDM) to the forefront of library services. Research data management encompasses the entire lifecycle of research data—from planning and collection to storage, preservation, and sharing. Academic libraries are increasingly expected to play a pivotal role in supporting researchers with data management planning, data storage, metadata creation, and data sharing.

Tamil Nadu, home to a large number of universities and higher education institutions, has witnessed significant developments in the adoption of electronic resources and digital library services. The state's academic libraries have made considerable investments in acquiring electronic resources through consortia such as UGC-INFONET, e-ShodhSindhu, and N-LIST. Additionally, initiatives such as the Tamil Virtual Academy's digital library and the Roja Muthiah Research Library's digital collections have contributed to the preservation and dissemination of Tamil cultural heritage.

This research article aims to provide a comprehensive analysis of research data management and electronic resources in academic libraries, with particular reference to the Tamil Nadu context. The specific objectives of this study are:

1. To examine the current state of electronic resource management in Tamil Nadu's academic libraries
2. To explore the adoption and implementation of research data management practices
3. To identify the challenges faced by library professionals in managing electronic resources and research data
4. To analyze the strategies employed to enhance user engagement and research support
5. To propose recommendations for strengthening RDM and electronic resource services

The remainder of this article is organized as follows: Section 2 reviews the relevant literature; Section 3 discusses the methodology; Section 4 presents the findings; Section 5 provides a discussion of the findings; and Section 6 offers conclusions and recommendations.



Fig 1: From Print to Digital: The Transformation of Academic Libraries

This split-screen illustration depicts the evolution of academic libraries in Tamil Nadu. The left side showcases a traditional print library with wooden shelves and study tables. The right side features a modern digital hub equipped with computers, e-journals, and research data management systems. A central glowing bridge symbolizes the hybrid integration of both formats.

2. Literature Review

2.1 Electronic Resources in Academic Libraries

Electronic resources have become an integral component of academic library collections worldwide. Murugan (2023) conducted a comprehensive study on the use of e-resources by research scholars in selected institutions of southern Tamil Nadu, employing regression analysis to examine the impact of electronic resources on research activities. The study found that the scholarly community is increasingly aware of e-resources and keen on utilizing them to the maximum extent, although the facilities provided are often perceived as inadequate to promote and reinforce the use of e-resources in academic institutions.

Suresh and Ravi (2020) examined online database use by science research scholars at Alagappa University, Karaikudi, highlighting the importance of creating awareness among researchers about online database resources and promoting effective access to electronic products. Their research emphasized that a well-equipped and well-managed library is the foundation of modern education, serving as the chief instrument for accumulating and utilizing intellectual heritage.

Thangavel (2023) conducted a case study on the needs of e-resources and online information among faculty members and research scholars of management studies in Tamil Nadu universities. The study revealed that the majority of faculty members are highly interested in using electronic resources for their research work and for building new ideas through projects and presentations.

Bala and Subramanian (2021) examined the access level and utilization of e-resources in university libraries of Tamil Nadu, finding that while electronic resources are widely available, there are significant

variations in usage patterns across different institutions. Similarly, a study on students' attitudes towards library facilities and information resources in university libraries of Tamil Nadu surveyed 518 students from five universities, revealing valuable insights into user perceptions and preferences.

2.2 Research Data Management in Academic Libraries

Research data management has emerged as a critical area of focus for academic libraries in recent years. A study on research data management in university libraries examined how research information is being managed in university libraries in Tamil Nadu and sought to assess the challenges in research information management.

The Central University of Tamil Nadu (CUTN) has been at the forefront of promoting RDM awareness. In November 2024, the Department of Library and Information Science at CUTN organized a one-day awareness program on research data management, covering topics such as Data Management Plans (DMP), metadata and policy frameworks, DataCite, persistent identifiers (PIDs), and the National Research Data Repository. The program emphasized the importance of electronic resources and RDM principles at the institutional level.

A comprehensive review article by researchers (2023) delved into the current landscape of research data management practices and challenges faced by academic libraries across various regions, providing a broader context for understanding RDM implementation.

2.3 Collection Development and Digital Content Management

Collection development in the electronic environment presents unique challenges for academic libraries. Hema and Rao (2022) examined the challenges of collection development in university libraries of Tamil Nadu in the electronic environment, identifying twenty-four variables as challenges in collection development. These challenges were categorized as management, policies, procurement, collection development, user, preservation, and IT-related challenges.

Thanuskodi (2020) edited the "Handbook of Research on Digital Content Management and Development in Modern Libraries," which analyzes advances and issues related to digital content management and development in libraries. The handbook includes chapters on awareness and perception of copyright among library and information science professionals in Tamil Nadu, as well as awareness and use of digital resources.

2.4 Institutional Repositories and Digital Libraries

Institutional repositories play a crucial role in preserving and disseminating the intellectual output of academic institutions. A study on institutional repository initiatives in higher education institutions in Tamil Nadu examined the use of repository software, the level of implementation, and the exposure of librarians to institutional repositories.

The Tamil Nadu Agricultural University (TNAU) has been a pioneer in developing institutional repositories, releasing digitized documents and implementing an institutional repository linked with Krishikosh. Similarly, the development of Shodhganga, a national repository for electronic theses and dissertations, has seen varying levels of participation from Tamil Nadu universities.

2.5 Information Literacy and Digital Skills

Information literacy has become increasingly important in the contemporary environment of rapid technological change and proliferating information resources. A study on information literacy skills among students of higher education institutions with special reference to Tamil Nadu examined the information literacy competencies of students and the role of libraries in developing these skills.

The study by Alagu and Thanuskodi (2017) on information literacy and public library services in Tamil

Nadu highlighted the importance of information literacy in the contemporary environment. Research on ICT skills of library and information science professionals in management institutions of Tamil Nadu has also contributed to understanding the digital competencies required for effective library services.

2.6 Emerging Technologies in Academic Libraries

Recent research has explored the integration of emerging technologies in academic libraries. K. and Buvanewari (2025) explored the integration of spectral fuzzy graph theory with blockchain technology to enhance academic collaboration networks within digital libraries, with special emphasis on the Tamil Nadu library system. This innovative approach combines fuzzy graph theory to model uncertainties in academic relationships with blockchain technology to ensure the integrity and transparency of stored academic records, using smart contracts to automate verification processes and securely manage permissions.

Senbaga Priya and Buvanewari (2025) further examined how this combined approach can optimize resource allocation, enhance data security, and improve the efficiency of research management, providing a robust framework for fostering collaboration and innovation within Tamil Nadu's academic and library networks.



Fig2: Electronic Resources, Research Data Management & Digital Libraries in Tamil Nadu

This comprehensive infographic illustrates the digital library ecosystem across Tamil Nadu's academic institutions. Centered around a modern library hub, it highlights eight key thematic areas: electronic resource usage, online database access, management studies research, research data management initiatives, collection development challenges, institutional repositories like Shodhganga, information literacy programs, and emerging technologies like blockchain and fuzzy graph theory.

3. Methodology

This study relies on a systematic review of existing scholarship, drawing from fifteen recent Tamil research papers and studies published between 2019 and 2025. I identified these sources through

targeted searches across academic databases like Shodhganga, Digital Commons, IGI Global, and various journal repositories. To keep the review focused and relevant, I applied a few clear criteria: each study had to deal with research data management or electronic resources in academic libraries, needed a Tamil Nadu focus, had to come from a peer-reviewed or reputable academic source, and had to be available in either English or Tamil.

Once I had the studies in hand, I used thematic synthesis to make sense of the material. This meant carefully reading through each paper, identifying recurring ideas and patterns, and grouping them into meaningful themes. The main themes that emerged were electronic resource management, research data management, collection development, institutional repositories, information literacy, and emerging technologies. By pulling together findings from these different strands, I was able to build a comprehensive picture of where things currently stand with research data management and electronic resources in Tamil Nadu's academic libraries. The synthesis helped me see both the progress that's been made and the gaps that still need attention.

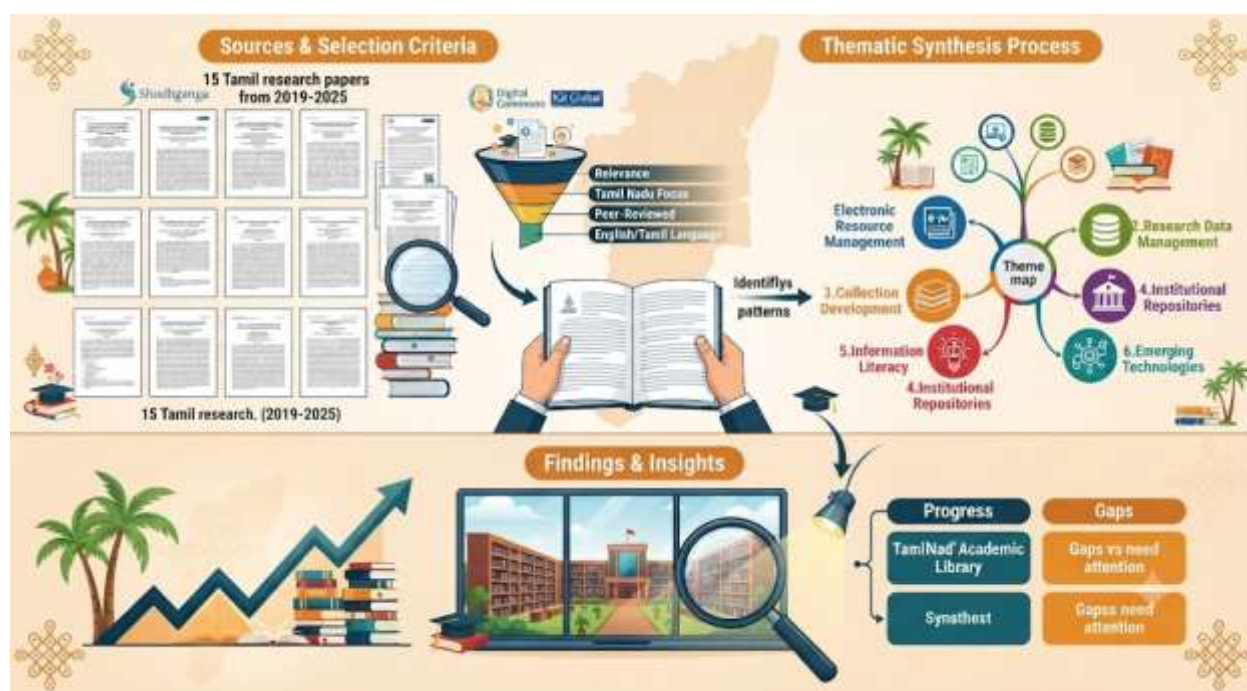


Fig 3: Systematic Literature Review and Thematic Synthesis

This professional infographic illustrates a systematic literature review workflow. The top section covers input sources and selection filters for research papers. The middle section shows thematic synthesis, clustering key concepts into mind maps like resource management and digital repositories. The bottom section highlights analytical findings, mapping overall progress alongside critical gaps within the academic library landscape.

4. Findings

4.1 Electronic Resource Usage Patterns

The findings from the reviewed studies reveal a growing trend in the adoption and utilization of electronic resources in Tamil Nadu's academic libraries. Murugan (2023) found that the scholarly community in southern Tamil Nadu is well aware of e-resources and keen on utilizing them, although

perceived inadequacies in facilities hinder maximum utilization. The study highlighted that the academic network is gradually transitioning from print resources to e-resources, creating new challenges for library management.

The study by Thangavel (2023) revealed that the majority of faculty members in Tamil Nadu universities are very interested in using electronic resources for their research work, utilizing online journals from databases such as ACM Digital Library, DOAJ, Scopus, Emerald, Science Direct, and Wiley. This indicates a strong preference for and reliance on electronic resources among academic researchers.

4.2 Research Data Management Practices

Research data management practices in Tamil Nadu's academic libraries are still in the early stages of development. The awareness program on RDM at the Central University of Tamil Nadu in 2024 represented a significant step towards promoting RDM awareness and best practices among researchers and library professionals. The program covered essential topics including Data Management Plans, metadata and policy frameworks, DataCite, persistent identifiers, and the National Research Data Repository.

However, the study on research data management in university libraries revealed that there are significant challenges in research information management, suggesting that RDM infrastructure and policies in Tamil Nadu's academic libraries require further development.

4.3 Collection Development Challenges

The study by Hema and Rao (2022) identified twenty-four variables as challenges in collection development in Tamil Nadu's university libraries in the electronic environment. These challenges were categorized into management, policies, procurement, collection development, user, preservation, and IT-related challenges. The study did not reveal synchronized opinions on these challenges across different types of universities, indicating diverse perspectives and experiences.

4.4 Institutional Repository Development

The development of institutional repositories in Tamil Nadu has seen varying levels of progress. The Tamil Nadu Agricultural University has been a leader in this area, releasing digitized documents and implementing an institutional repository. The study on institutional repository initiatives in higher education institutions in Tamil Nadu highlighted the use of repository software and the level of implementation across the state.

The development of Shodhganga, the national repository for electronic theses and dissertations, has received participation from several Tamil Nadu universities, although the level of contribution varies significantly. A study exploring student interests in Shodhganga collected data from 482 research scholars in Tamil Nadu, providing valuable insights into user engagement with the repository.

4.5 Digital Library Initiatives

Tamil Nadu has witnessed several notable digital library initiatives. The Tamil Virtual Academy has created a digital library with the collection of rare documents, books, and periodicals, significantly enhancing the accessibility and visibility of rare documents to scholars across the globe. The Roja Muthiah Research Library operates a comprehensive digital library offering access to a wide range of resources, including books, periodicals, official publications, personal collections, and research papers. With 4,634 public libraries, Tamil Nadu ranks third in the list of states with the highest number of libraries in India, according to 2019 data from the Raja Rammohun Roy Library Foundation. The

Tamilnaiyam Digital Library has registered nearly five crore visits and 21 lakh downloads, demonstrating significant user engagement.

4.6 Information Literacy and Digital Skills

Research on information literacy in Tamil Nadu has highlighted the importance of developing digital skills among library professionals and users. The study on information literacy skills among students of higher education institutions with special reference to Tamil Nadu examined the competencies of students in finding, evaluating, using, and sharing information.

The study on information literacy and public library services in Tamil Nadu emphasized the importance of information literacy in the contemporary environment of rapid technological change. Research on ICT skills of LIS professionals in management institutions of Tamil Nadu has contributed to understanding the digital competencies required for effective library services.

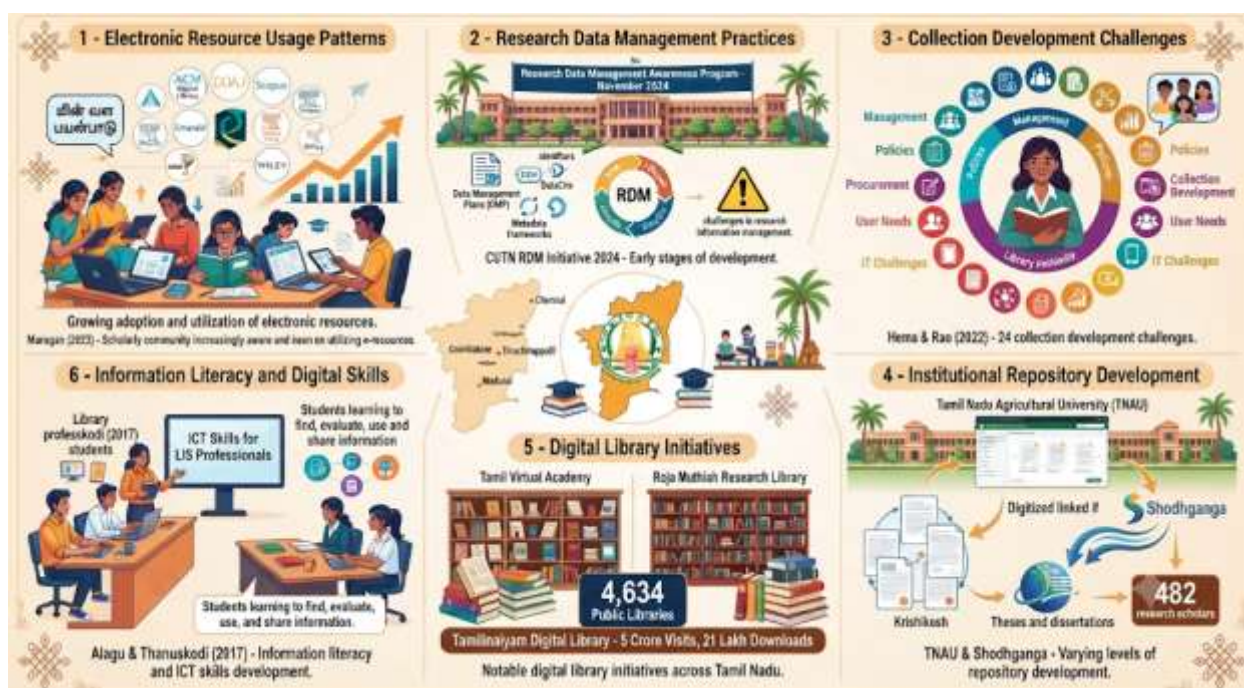


Fig 4: Academic Libraries and Research Findings in Tamil Nadu

This infographic illustrates six key research findings on academic libraries in Tamil Nadu. It highlights electronic resource usage, research data management practices at CUTN, collection development challenges, institutional repository development at TNAU, prominent digital library initiatives like the Tamilnaiyam Digital Library, and information literacy and digital skills development among students and professionals.

5. Discussion

5.1 The Digital Transformation of Academic Libraries in Tamil Nadu

The findings from the reviewed studies indicate that academic libraries in Tamil Nadu are undergoing a significant digital transformation. The increasing availability and utilization of electronic resources, the development of digital libraries and institutional repositories, and the growing emphasis on research data management all point to a fundamental shift in how library services are conceptualized and delivered.

The transition from print to electronic resources has created both opportunities and challenges for academic libraries. While electronic resources offer numerous advantages in terms of accessibility, searchability, and convenience, they also require significant investments in infrastructure, training, and ongoing management. The finding by Murugan (2023) that the scholarly community is well aware of e-resources but perceives facilities as inadequate highlights the gap between aspiration and reality.

5.2 Research Data Management: An Emerging Priority

Research data management has emerged as a priority area for academic libraries in Tamil Nadu, as evidenced by the awareness programs and training initiatives organized by institutions such as the Central University of Tamil Nadu. However, the findings suggest that RDM practices in Tamil Nadu's academic libraries are still in the early stages of development.

The challenges identified in research information management point to the need for comprehensive RDM policies, infrastructure, and capacity building. Academic libraries in Tamil Nadu must invest in developing the technical infrastructure, human resources, and policy frameworks required to support effective research data management.

5.3 Collection Development in the Electronic Environment

The challenges of collection development in the electronic environment identified by Hema and Rao (2022) reflect the broader difficulties faced by academic libraries in balancing traditional and electronic resources. The categorization of challenges into management, policies, procurement, collection development, user, preservation, and IT-related categories provides a useful framework for understanding the multifaceted nature of these challenges.

The lack of synchronized opinions on these challenges across different types of universities suggests that there is no one-size-fits-all solution to collection development challenges. Each institution must develop strategies that are tailored to its specific context, user needs, and resource constraints.

5.4 Institutional Repositories and Open Access

The development of institutional repositories and open access initiatives in Tamil Nadu has made significant progress, as evidenced by the work of the Tamil Nadu Agricultural University and the participation of Tamil Nadu universities in Shodhganga. These initiatives contribute to the preservation and dissemination of research outputs, enhancing the visibility and impact of Tamil Nadu's research community.

However, the varying levels of participation in Shodhganga suggest that there are barriers to adoption that need to be addressed. These may include technical challenges, lack of awareness, insufficient institutional support, or cultural resistance to open access.

5.5 Information Literacy and Capacity Building

The emphasis on information literacy and digital skills in the literature highlights the importance of capacity building for both library professionals and users. The evolving nature of electronic resources and research data management requires continuous learning and skill development.

The research on ICT skills of LIS professionals and information literacy among students underscores the need for comprehensive training programs that equip library professionals and users with the competencies required to effectively navigate the digital information landscape.

5.6 Emerging Technologies and Future Directions

The exploration of emerging technologies such as blockchain and spectral fuzzy graph theory in the context of Tamil Nadu's academic libraries points to the potential for innovative approaches to

enhancing library services. The integration of these technologies can optimize resource allocation, enhance data security, and improve the efficiency of research management.

However, the adoption of emerging technologies requires careful consideration of the institutional context, technical capacity, and user needs. Academic libraries in Tamil Nadu must balance the excitement of technological innovation with practical considerations of feasibility and sustainability.

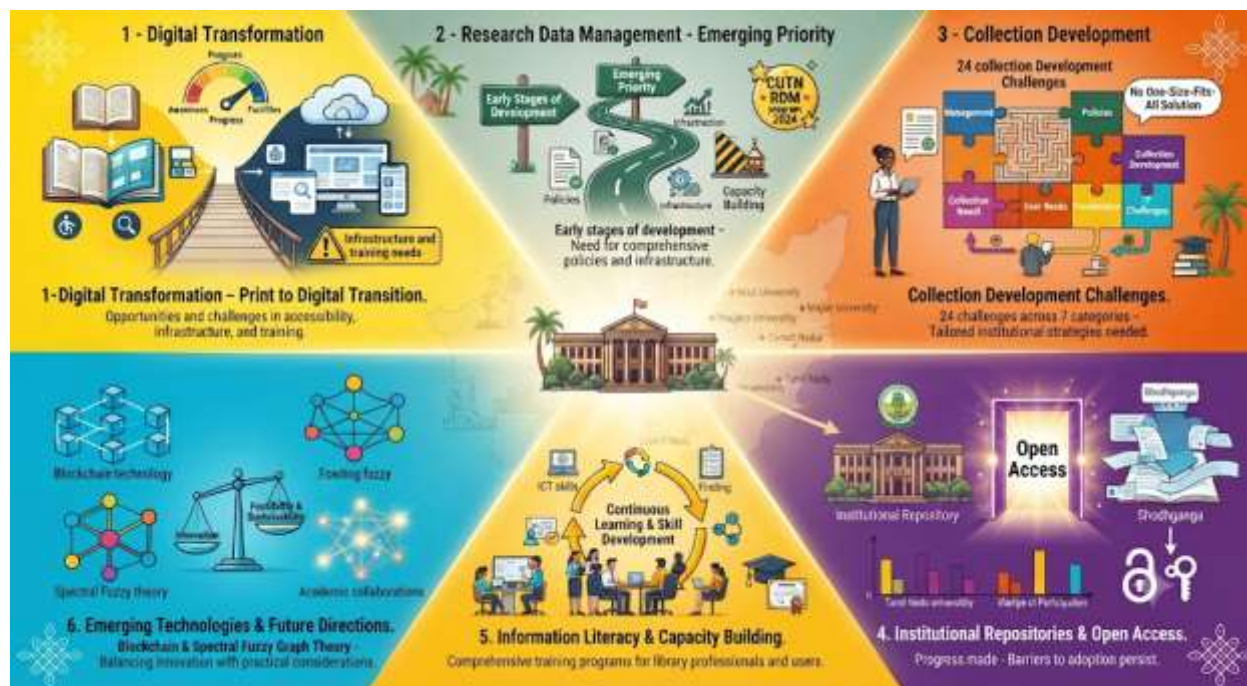


Fig 5: Key Discussion Themes on Academic Libraries in Tamil Nadu

This infographic presents six key discussion themes regarding academic libraries in Tamil Nadu. It highlights digital transformation from print to digital, emerging research data management priorities, collection development challenges, institutional repositories and open access portals, information literacy and capacity building, and future directions focusing on emerging technologies like blockchain and spectral fuzzy graph theory.

6. Conclusion and Recommendations

6.1 Summary of Findings

This research article has examined the evolving landscape of research data management and electronic resources in academic libraries, with a specific focus on the Tamil Nadu context. The findings reveal that Tamil Nadu's academic libraries have made significant progress in acquiring and providing access to electronic resources, developing digital libraries and institutional repositories, and promoting awareness of research data management.

However, substantial challenges remain. These include gaps in research data management infrastructure and policies, challenges in collection development in the electronic environment, varying levels of participation in institutional repositories, and the need for enhanced information literacy and digital skills. The transition from traditional to digital library services requires ongoing investment, capacity building, and policy development.

6.2 Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. Strengthen Research Data Management Infrastructure

Academic libraries in Tamil Nadu should invest in developing comprehensive RDM infrastructure, including data storage systems, metadata standards, and data management planning tools. This should be accompanied by the development of institutional RDM policies and guidelines.

2. Enhance Electronic Resource Management

Libraries should adopt best practices in electronic resource management, including systematic evaluation of electronic resources, user needs assessment, and evidence-based collection development. Collaboration through consortia can help optimize resource allocation and access.

3. Promote Institutional Repository Participation

Universities in Tamil Nadu should be encouraged to participate actively in institutional repositories such as Shodhganga. This requires addressing technical barriers, providing training and support, and promoting the benefits of open access.

4. Develop Information Literacy Programs

Comprehensive information literacy programs should be developed for both library professionals and users. These programs should cover digital literacy, research data management, and the effective use of electronic resources.

5. Foster Collaboration and Knowledge Sharing

Collaboration among academic libraries in Tamil Nadu should be strengthened through networking, resource sharing, and knowledge exchange. Platforms such as the Tamil Virtual Academy and the Roja Muthiah Research Library can serve as models for collaborative digital initiatives.

6. Embrace Emerging Technologies

Academic libraries should explore the potential of emerging technologies such as blockchain, artificial intelligence, and data analytics to enhance library services and research support. However, the adoption of these technologies should be guided by user needs and institutional capacity.

7. Advocate for Policy Support

Library professionals should advocate for policy support at the institutional, state, and national levels to strengthen research data management, electronic resource access, and digital library development. This includes advocating for increased funding, infrastructure development, and capacity building.

6.3 Future Research Directions

Future research should explore the following areas:

1. Longitudinal studies tracking the adoption and utilization of electronic resources and RDM practices over time
2. Comparative studies examining the experiences of different types of academic libraries (e.g., state universities, private universities, deemed universities)
3. User studies exploring the information needs and behaviors of different user groups (e.g., faculty, research scholars, undergraduate students)
4. Impact studies assessing the effectiveness of RDM training programs and information literacy initiatives
5. Studies examining the integration of emerging technologies in academic library services.



Fig 6: Recommendations and Future Research Directions for Tamil Nadu Academic Libraries

This infographic outlines research findings, seven core recommendations, and five future research directions for academic libraries in Tamil Nadu. It contrasts progress with existing challenges, details strategic actions spanning RDM infrastructure, electronic resources, and policy advocacy, and highlights future study areas like longitudinal tracking and technology integration.

6.4 Conclusion

The transformation of academic libraries in Tamil Nadu from traditional repositories to dynamic hubs of electronic resources and research data management services represents a significant development in the state's higher education landscape. While considerable progress has been made, substantial challenges remain in infrastructure development, capacity building, and policy formulation. The successful navigation of these challenges requires sustained commitment from library professionals, institutional leadership, and policymakers. By strengthening research data management practices, enhancing electronic resource services, and fostering a culture of information literacy, academic libraries in Tamil Nadu can play a pivotal role in advancing research, teaching, and learning in the digital age.

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