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DR. B. YUGANDHAR LIBRARIAN

Dr. B. Yugandhar is currently serving as a Librarian in the Department of Library & Information Science at Pingle Government College for Women (Autonomous), Telangana. With a strong academic background, Dr. Yugandhar holds a Ph.D. in Library and Information Science from JNTU Kakinada, awarded in 2020. He also holds postgraduate degrees including M.L.I.Sc. from Madurai Kamaraj University (2003), M.Sc. in Zoology from Osmania University (1997), M.A. in Hindi from Hindi Mahavidyalaya (1993), and a B.Ed. in Bio Sciences. Additionally, he completed his B.A. in English Literature from Ambedkar Open University in 2004.

Dr. Yugandhar brings over 25 years of professional experience to the field of education and library sciences. He began his career as a Teacher in the District Education Department (1998–2009), later worked as a Librarian in Intermediate Education (2009–2013), and has been serving in Higher Education as a Librarian since 2013. He has also held academic administrative roles, notably serving as an NSS Programme Officer from 2020 to 2024, served as a facilitator to Telangana state Degree colleges for Oasis National program and motivated many degree college students as a co- coordinator for Pillala Kosam Community Program.

He has published more than 30 research papers in National and International journals conferences. He owned two patents and his research areas of research interest include user studies and electronic resource management. He has authored and published more than ten research papers in reputed national and international journals and has presented at various conferences including JNTUK LIBCON, LISSASPAC, and the Indian Statistical Institute, Bangalore. He authored a book titled with Facilities and Services in Degree College Libraries Affiliated to Kakatiya University, Warangal District (Composite): A User Study. His scholarly contributions also include book chapters such as "Library: A Knowledge Hub" and "Development of Digital Library: Major Issues – A Perspective." He is a member of the editorial board of the Glacier Journal of Scientific Research and a Member of the Telangana State Library Association.

Committed to continuous professional development, Dr. Yugandhar has participated in various orientation and refresher courses conducted by UGC-HRDCs at UOH, MANUU, OU, and Delhi University. He has also completed several Faculty Development Programmes (FDPs), workshops, and webinars on contemporary topics like SOUL 3.0 ILMS, ICT, plagiarism, and library automation.

Dr. B. Yugandhar is a dedicated academic and librarian who continues to contribute significantly to the advancement of library and information sciences, particularly in the context of digital transformation and user-centric services.

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FROM TRADITIONAL TO DIGITAL TRANSFORMATION IN LIBRARY AND INFORMATION SCIENCE: A 21ST CENTURY ANALYSIS

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ABSTRACT

"Libraries are the living memory of mankind." Aldous Huxley

It is difficult to conceive the evolution of books and libraries without the profound influence of technology. Although technological advancements are reshaping the functions and services of books and libraries, they are not replacing them. To sustain their role as information professionals, librarians must adopt and extensively integrate Information and Communication Technologies (ICT) into their operations. This paper examines how information communication technology has transformed library and information science in the 21st century. Libraries must evolve to meet the expectations of tech-savvy users who demand convenient, remote access to information resources. The study highlights two major developments. First, ICT has revolutionized how libraries collect, organize, and distribute information, moving beyond traditional physical systems. Second, the paper explores Radio Frequency Identification (RFID) technology, which uses radio waves to automatically identify tagged items like books, streamlining circulation, inventory management, and security processes. The Main objective of the paper is to study the impact and significance of the digital services on the users while applying the modern technical acumen, ICT tools with a special emphasis on digital services in Libraries and other e resources.
By examining models, evaluation methods, and real-world examples, the present study discusses strategies for enhancing user-centered design in Library and Information Science emphasizing the integration of emerging technologies like AI for better accessibility and privacy. The paper argues that technological integration is essential for libraries to remain relevant and effectively serve contemporary information needs.

Keywords: *Library and Information Science, Radio Frequency, Identification, Auto Identification, Data collection technology, Radio waves*

Introduction

The evolution of books and libraries is inseparable from technology. While advancements reshape their functions, they do not replace them. Librarians must integrate ICT to remain effective. This paper examines ICT's impact on library science in the 21st century, focusing on two developments: the shift from physical to digital systems for organizing and distributing information, and the use of RFID to streamline circulation, inventory, and security. The study's objective is to assess the significance of digital services and e-resources for modern library users.

The integration of information and communication technology (ICT) has fundamentally transformed libraries in recent years, mirroring ICT's substantial impact across law, banking, medicine, and engineering (Gholami, et al., 2018). Liu and Briggs (2015) note that ICT plays a crucial role in education by developing citizens equipped for the information society. The theoretical framework uses the Unified Theory of Acceptance and Use of Technology (UTAUT) to understand how library patrons adopt new technological systems. Modern users possess considerable digital proficiency and expect library services to mirror their everyday technological experiences—seamless searching, remote access, and instant availability. Libraries that fail to adapt risk obsolescence as patron expectations increasingly align with commercial information services.

John Palfrey, R. David Lankes, and Neil Gaiman are notable voices on libraries' adaptation to digital technologies, highlighting evolution, enhanced services, and the importance of human mediation beyond mere digitization. Neil Gaiman once remarked that while Google can provide 100,000 answers, a librarian can provide the right one and acknowledged them as unsung heroes of the technological world (*as quoted in Quote Investigator, 2016).*

> "Google can bring you back 100,000 answers. A librarian can bring you back the right one. Librarians are the unsung heroes of the information age."

Libraries initially adopted technology to manage bibliographic, financial, and other records more efficiently. Uzwyshyn (2017) argues that Internet and intranet technologies enhanced these capabilities by enabling seamless local and global information sharing, surpassing the limitations of computers and CD-ROMs. Traditional information dissemination methods have largely shifted to electronic communication, improving access while creating new roles in information provision and transfer. According to Bhoi (2017), 21st-century libraries serve as gateways to knowledge and support lifelong learning,

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enabling independent decision-making for individual and societal development. Abdekhoda, Ahmadi, Dehnad, Noruzi, and Gohari (2016) observe that modern ICT advances have revolutionized how libraries accumulate, manage, and disseminate scientific and technical information. Research and academic libraries have transformed their operations by integrating electronic resources and services.

Information science is an interdisciplinary field that investigates the properties, behavior, and flow of information, focusing on optimizing its accessibility and usability. The discipline encompasses the entire information lifecycle: origination, collection, organization, storage, retrieval, interpretation, transmission, transformation, and utilization. The field examines how information is represented in natural and artificial systems, explores efficient coding for message transmission, and studies information processing devices and techniques, including computers and programming systems. Information science draws from and relates to multiple disciplines, including mathematics, logic, linguistics, psychology, computer technology, operations research, graphic arts, communications, library science, and management. While some initially viewed ICT as a threat to traditional libraries, Bejalwar (2018) contends that the Internet has redefined the library's role in academia and society. Although digital technology and mobile devices have provided students with alternative research methods, potentially reducing physical library usage in developing countries, ICT ultimately enhances library services by enabling librarians to reach more users effectively. ICT has facilitated knowledge construction in electronic formats, electronic file transfer, and increased digital learning opportunities (Bhoi, 2017).

Methodology

This qualitative literature review methodology provides a systematic, rigorous approach to examining ICT integration in library and information science. While limitations exist regarding primary data collection and generalizability, the comprehensive analysis of scholarly literature offers valuable insights into technological transformation in libraries, evolving professional roles, and emerging service models. The methodology's transparency and systematic nature support the study's credibility while identifying directions for future empirical research addressing identified gaps in the literature. This study employs a qualitative research design utilizing a comprehensive literature review approach to examine the integration of information communication technology (ICT) in library and information science during the 21st century. The descriptive and analytical methodology allows for systematic examination of existing scholarly literature, identifying patterns, themes, and trends regarding technological transformation in library services, e-learning platforms, and evolving librarian competencies.

The study is grounded in the Unified Theory of Acceptance and Use of Technology (UTAUT), which provides a theoretical lens for understanding how library users and professionals adopt and integrate technological innovations. UTAUT examines four key constructs influencing technology acceptance: performance expectancy, effort expectancy, social influence, and facilitating conditions. This framework guides the analysis of factors affecting ICT adoption in library contexts and helps explain user behavior patterns' regarding digital library services. Data collection relies exclusively on secondary sources through systematic literature review. The review encompasses peer-reviewed journal articles, conference proceedings, books, and authoritative publications addressing ICT integration in libraries. Sources were selected based on relevance to the research objectives, publication credibility with emphasis on literature published between 2015 and 2023 to capture contemporary developments while maintaining historical context.

Review of Literature

The integration of information communication technology in library and information science has generated substantial scholarly discourse examining its transformative impact on library operations, user expectations, and professional roles. This review synthesizes key literature addressing technological evolution in libraries, e-learning platforms, and the changing competencies required of modern librarians.

ICT Impact on Library Services

Gholami et al. (2018) establish that emerging technologies have significantly influenced educational technology, fundamentally altering how libraries function as information providers. This transformation extends beyond education, affecting multiple sectors including law, banking, medicine, and engineering. Liu and Briggs (2015) emphasize ICT's role in developing citizens equipped for the information society, highlighting technology's broader societal implications. Uzwyshyn (2017) argues that Internet and intranet technologies have provided advantages surpassing earlier computer and CD-ROM capabilities by enabling seamless local and global information sharing. This evolution has shifted libraries from traditional information repositories to dynamic access points for digital resources.

Bhoi (2017) characterizes 21st-century libraries as gateways to knowledge supporting lifelong learning and enabling independent decision-making for individual and societal development. Abdekhoda et al. (2016) note that modern ICT

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advances have revolutionized information accumulation, regulation, and dissemination in academic and research libraries. Contrary to predictions that ICT would eliminate libraries, Bejalwar (2018) demonstrates that the Internet has redefined rather than diminished the library's place in academia and society. Khan and Bhatti (2017) support this view, documenting how libraries have rebounded by embracing innovation and transforming into technology-fueled community centers rather than obsolete institutions.

E-Learning and Virtual Learning Environments

The literature extensively addresses e-learning as a pivotal development in library services. Lippincott (2015) defines e-learning as technological infrastructure managing courses and users, while Nagel (2016) describes it as telecommunication technology providing education-related information. Gomes and Mazzilly (2016) argue that e-learning encompasses broader educational services beyond mere course content delivery, offering flexible learning methods that promote mobile technology adoption. Research distinguishes between synchronous and asynchronous learning modalities. Synchronous learning facilitates real-time interaction and collaboration, fostering open-mindedness and improving writing skills. Asynchronous learning provides flexibility particularly beneficial for students with health issues or childcare responsibilities, allowing self-paced progression without classroom constraints.

Cosgrave and Kosturski (2016) identify Massive Open Online Courses (MOOCs) as a rising trend in higher education, utilizing electronic distance learning technologies to accommodate unlimited students simultaneously at minimal or no cost. Gomes and Mazzilly (2016) highlight Coursera as a prominent example with over 2.9 million users and 328 courses, emphasizing MOOCs' open-access nature and their role in fostering micro-learning through microstructures. However, Pietersen (2015) raises copyright concerns, noting that proprietary materials available in standard university courses require special permissions in open online environments.

Fielden and Middlehurst (2017) discuss terminology variations across regions, noting that Learning Management Systems (LMS), Virtual Learning Environments (VLE), and Management Learning Environments (MLE) serve different but complementary functions. VLEs assist content creation and performance assessment, while MLEs provide holistic infrastructure integrating administrative processes with electronic learning support.

Evolving Librarian Roles and Competencies

The literature consistently emphasizes how ICT has transformed librarian roles from book-centered to user-centered approaches. Shukla and Sialai (2016) describe 21st-century librarians as creators, communicators, leaders, mentors, and lifelong learners who continuously monitor technology trends. Pietersen (2015) argues that new collection development tools require different personalities, skills, and knowledge, with emphasis on integrating digital environments and providing mobile wireless access.

Craig and Williams (2015) identify challenges facing modern librarians regarding collections, information environments, and changing user expectations. They emphasize required competencies including accelerating information access, filtering materials, organizing sources using standardized classifications, and developing expert vocabularies. Uzwyshyn (2017) stresses that librarians must analyze organizational readiness before implementing changes, requiring curiosity, adaptability, flexibility, and global thinking.

Shukla and Sialai (2016) propose nine key factors for successful change management: ensuring readiness, planning, leading, managing and supporting change, addressing resistance, communicating effectively, evaluating and learning, and attending to human factors. Craig and Williams (2015) assert that creativity is essential for managing changes and that librarian's serve as accessibility agents connecting users to digital information while re-tooling services for customization.

ICT-Enabled Library Services

Contemporary literature documents specific ICT-integrated services transforming library operations. Notification services enable instant communication about new acquisitions, overdue items, and events through social media and automated management systems. User instruction services provide podcasts and videos on information literacy accessible via mobile devices, eliminating search difficulties for new users. E-resource services offer access to databases, e-books, e-journals, and multimedia content downloadable to personal or borrowed devices. Virtual library tours orient users inexpensively, reducing staff time while helping remotely located individuals navigate facilities. Outreach services promote library work and foster inter-library cooperation while encouraging educational institutions to adopt innovative teaching methods. While the literature extensively discusses practical ICT applications, Asseo (2016) and Pietersen (2015) highlight theoretical considerations including copyright challenges in digital environments. The Unified Theory of Acceptance and Use of Technology (UTAUT) provides a theoretical lens for understanding user adoption of library technologies, though the reviewed literature lacks extensive discussion of this framework's specific application to library contexts.

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ICT-Integrated Library Services in the 21st Century

ICT plays a crucial role in modern libraries. Librarians must adopt extensive ICT use in operations to maintain their role as information professionals, as neglecting technology leads to stagnation and service deterioration. Most libraries now integrate ICT across various services:

Notification Service

ICT enables libraries to notify users about news, events, and information through messages, posts, comments, and tweets on social media. Users receive instant alerts regarding new books, document arrivals, reserved items availability, overdue notices, outstanding fines, renewal reminders, library circulars, e-journal subscriptions, schedule changes, and important events. Integrated library management systems generate these notifications automatically, with broadcast options allowing simultaneous messaging to user groups, creating efficient communication for both librarians and patrons.

User Instructions

This service assists users in precise information searching by teaching them to use mobile technologies for library research. Libraries offer podcasts and videos on information literacy accessible via MP3 players and other devices. New users receive orientation to the research environment, eliminating search difficulties. Social media enables direct user-librarian engagement, allowing users to post questions on library accounts and receive timely feedback.

E-Resources Service

Publishers deliver e-books (text and audio) accessible via ICT, offering databases and digital resources including e-books, e-journals, web databases, dissertations, audiobooks, streaming music, films, images, and article databases usable on mobile devices. Users can download collections from library social media to personal devices or borrow library devices with pre-installed content. Libraries upload photos and videos on social media to promote resources—showcasing new books and broadcasting conferences for absent users. Students access library social media accounts 24/7 when internet terminals are available.

Library Tour Service

Library tours orient new users and help remotely located individuals navigate facilities. Virtual or audio tours can be produced quickly and inexpensively via ICT, reducing staff time spent on orientation. These tours familiarize users with library layouts, helping them locate information resources, restrooms, reprography spaces, and administrative offices.

Outreach Service

Librarians use ICT for outreach with two objectives: promoting library work and connecting with broader library communities. Libraries utilize ICT to disseminate faculty research widely through their own channels and research-focused services. ICT enables inter-library communication about new content and operational modes, fostering cooperation within library associations. Libraries conduct outreach to schools, introducing innovative student engagement methods that enhance academic performance and encourage ICT use for learning and research rather than entertainment.

Scope of the Study

This paper examines the integration of information communication technology in library and information science within the 21st-century context. It explores technological advancements including RFID systems, e-learning platforms (synchronous and asynchronous learning, MOOCs), virtual learning environments, and ICT-enabled library services. The study addresses how technology has transformed librarian roles, user expectations, and service delivery models, using the Unified Theory of Acceptance and Use of Technology (UTAUT) as its theoretical framework.

Limitations

This study acknowledges several limitations. First, the research primarily focuses on technological adoption in academic and public libraries, potentially limiting applicability to specialized library contexts. Second, the rapid evolution of ICT means some discussed technologies may become outdated quickly. Third, the study does not comprehensively address the digital divide affecting users in developing regions with limited internet access or technological infrastructure. Fourth, implementation costs and budget constraints facing libraries, particularly in resource-limited settings, receive limited attention. Finally, the study does not deeply explore resistance to technological change among library staff or users who prefer traditional services.

Conclusion

The integration of ICT has fundamentally transformed library and information science in the 21st century, shifting focus from book-centered to user-centered librarianship. Technology has revolutionized how libraries accumulate, organize, and disseminate information, introducing innovations like RFID systems, e-learning platforms, MOOCs, and virtual learning

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environments that provide flexible, accessible learning opportunities. Modern librarians have evolved into creators, communicators, mentors, and digital curators who continuously adapt to technological trends while maintaining core information management principles. ICT-enabled services—including notification systems, user instructions, e-resources, virtual tours, and outreach programs—demonstrate how libraries have successfully integrated technology to enhance user experience and expand service reach.

Rather than rendering libraries obsolete, ICT has revitalized their role as dynamic community centers and information hubs. While search engines provide quick information access, librarians remain essential for ensuring information quality, guiding effective research, and fostering digital literacy. The successful integration of traditional librarianship values with modern technological capabilities positions libraries as indispensable institutions in the digital age. Moving forward, libraries must continue embracing innovation while addressing challenges such as copyright considerations, digital equity, and evolving user expectations. By maintaining adaptability, fostering collaboration, and prioritizing user needs, libraries will remain vital educational and cultural resources that bridge the gap between information abundance and meaningful knowledge acquisition.

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ACCESS TO ARTIFICIAL INTELLIGENCE IN ACADEMIC LIBRARIES: TEACHING, LEARNING AND RESEARCH (TLR)

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ABSTRACT
This paper deals with the Access to Artificial Intelligence Tools in Teaching, Learning and Research (TLR) , Artificial Intelligence Applications in Education and Libraries, Emerging trends in AI are transforming both education and libraries, Dr.S R Ranganathan's Five Laws of Library science in AI Age, offering new tools and approaches for learning and information management.AI uses and Teaching, Learning and Research purposes. AI is being integrated into educational systems to personalize learning, automate tasks, and provide intelligent tutoring. In libraries, AI is used for tasks like information retrieval, cataloging, and user engagement, leading to more efficient and personalized services

Keywords: *Access, Artificial intelligence, Teaching, Learning, Research, Ai-Powered, US Dept. of Education, Education, Libraries, UNESCO.*

"Artificial Intelligence for all" must be that everyone can take advantage of the technological revolution under way and access its fruits, notably in terms of innovation and knowledge. -*UNESCO*

Introduction to Artificial Intelligence

Artificial Intelligence (AI) in education is transforming learning by personalizing education, automating tasks, and providing accessible learning experiences, ultimately aiming to enhance student engagement and improve learning outcomes. Artificial intelligence is enabling the development of invaluable services and taking part in more and more aspects of our lives. Built from data, hardware and connectivity, AI allows machines to mimic human intelligence such as perception, problem-solving, linguistic interaction or creativity. These technologies contribute to achieving the 2030 Agenda for Sustainable Development. However, these rapid changes raise major issues. UNESCO addresses these matters, from ethics of AI, AI in education, gender equality, to capacity building for governments and judiciary. Artificial Intelligence (AI) has the potential to address some of the biggest challenges in education today, innovate teaching and learning practices, and accelerate progress towards Sustainable Development Goals.

UNESCO's mandate calls inherently for a human-centered approach to AI. It aims to shift the conversation to include AI's role in addressing current inequalities regarding access to knowledge, research and the diversity of cultural expressions and to ensure AI does not widen the technological divides within and between countries. The promise of *"Artificial Intelligence for all"* must be that everyone can take advantage of the technological revolution under way and access its fruits, notably in terms of innovation and knowledge. Within the *framework of the Beijing Consensus, UNESCO developed Artificial Intelligence and Education: Guidance for Policy-makers* to foster the readiness of education policy-makers in artificial intelligence.. UNESCO also published AI competency frameworks for students and teachers to guide countries in supporting students and teachers to understand the potential as well as risks of AI.

Generative AI can be seen as a form of creative expression, where the machine collaborates with the human to produce novel and valuable outcomes. Generative AI can also be used to augment and enhance human creativity, by providing suggestions, feedback, and alternatives. AI isn't one single technology: it's a toolbox overflowing with possibilities.

- Machine Learning: Systems that "learn" by uncovering patterns in massive datasets.
- Deep Learning: Advanced techniques, mimicking our brains, for tasks like image and voice recognition.
- Natural Language Processing: Enabling computers to understand and communicate like humans do.
- Generative AI: The creative force producing and generating amazing text, images, and even code automatically with simple prompts.

"I strongly believe in the need for stakeholders to understand the cyclical effects of AI and education.
By understanding how different activities accrue, we have the ability to support virtuous cycles.
Otherwise, we will likely allow vicious cycles to perpetuate." —Lydia Liu

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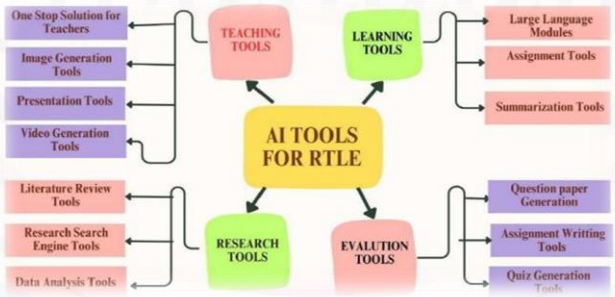
The U.S. Department of Education is committed to supporting the use of technology to improve teaching and learning and to support innovation throughout educational systems. This report addresses the clear need for sharing knowledge and developing policies for "Artificial Intelligence," a rapidly advancing class of foundational capabilities which are increasingly embedded in all types of educational technology systems and are also available to the public. We will consider "educational technology" (edtech) to include both (a) technologies specifically designed for educational use, as well as (b) general technologies that are widely used in educational settings. Recommendations in this report seek to engage teachers, educational leaders, policy makers, researchers, and educational technology innovators and providers as they work together on pressing policy issues that arise as Artificial Intelligence (AI) is used in education.

Dr. S R Ranganathan's Five Laws of Library Science in AI Age	Key AI Features
1. Books for Use: Artificial Intelligence for Use	Discovery platforms, chatbots, open-access AI interfaces
2. Every Reader his/her Book: Every Patron his/her AI Tool	Personalized recommendation engines, user profiling ML
3. Every Book Its Reader: Every Artificial Intelligence for Patron	Metadata matchmaking algorithms, targeted notifications
4. Save the Time of the Reader: Save The Time of The Patron	Automated cataloging (NLP/ML), predictive analytics, RFID integration
5. Library is a Growing Organism: Artificial Intelligence is a Growing Systems	Cloud-based retraining, modular AI updates, VR/AR integration

Rising Interest in AI in Education: Today, many priorities for improvements to teaching and learning are unmet. Educators seek technology-enhanced approaches addressing these priorities that would be safe, effective, and scalable. Naturally, educators wonder if the rapid advances in technology in everyday lives could help. Like all of us, educators use AI-powered services in their everyday lives, such as voice assistants in their homes; tools that can correct grammar, complete sentences, and write essays; and automated trip planning on their phones. Many educators are actively exploring AI tools as they are newly released to the public1 . Educators see opportunities to use AI-powered capabilities like speech recognition to increase the support available to students with disabilities, multilingual learners, and others who could benefit from greater adaptively and personalization in digital tools for learning. They are exploring how AI can enable writing or improving lessons, as well as their process for finding, choosing, and adapting material for use in their lessons.

AI Tools in Teaching, Learning and Research

Where, a prompt is a concise textual input that the Generative AI Bot uses to generate the output based on its functionality.



Wide range of AI tools tailored for education sector:

- Generative AI as a game changer: Generative AI revolutionizes education by personalizing content, fostering collaboration, and promoting creativity.
- AI-powered Assistants: These intelligent companions offer on demand support, answering student questions, providing guidance, and even acting as a practice partner for language learning.
- Adaptive Learning Platforms: These AI-driven platforms leverage student data to personalize learning paths, offering targeted practice exercises, and adapting to individual pace and understanding.

Objectives of Paper:

- To know the access of Artificial Intelligence Academic in Education Libraries
- To identify the AI in Teaching, Learning and Research.
- To Study the future of AI use in Teaching, Learning and Research.

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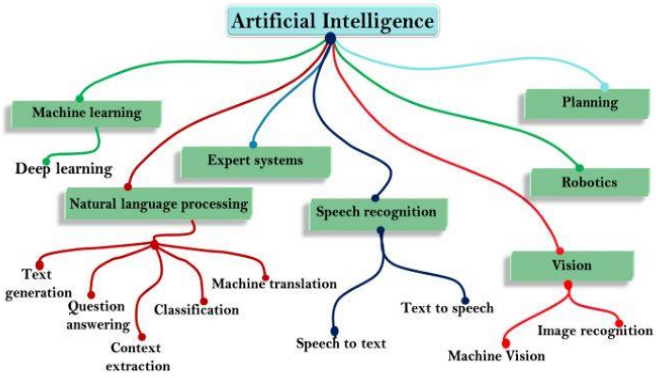
Artificial Intelligence in Teaching

"AI in education can only grow at the speed of trust." —Dr. Dale Allen

Adapting teaching practices in response to AI: Natural language AI chatbots such as ChatGPT use vast amounts of text data to predict words or phrases in a given context. They can be used to mimic natural human language and to aid a wide variety of language-related tasks in much more sophisticated ways than previously possible. Other emerging AI tools, also trained on large datasets, focus on producing computer code and images in response to user prompts. At the Center for Teaching and Learning (CTL), we have heard a lot of interest, concerns, and questions from the campus community.



AI Tools in Teaching-Tools to Create Presentations

Launch a transformative journey in your classroom by harnessing the power of AI to revolutionize your teaching methods, empower students, and delve into a realm of insights through the infusion of creativity in your teaching and learning practices. Prepare to create visually engaging lessons, support student-led projects, and gather actionable data to enhance your teaching using cutting-edge AI tools like Gamma AI, Tome, Beautiful.ai, Slides.ai, SlidesGo, and Canva. AI is the science and engineering of creating machines and systems that can perform tasks that normally require human intelligence, such as understanding language, recognizing images, solving problems, and learning from data. AI has been advancing rapidly in recent years, thanks to the availability of large amounts of data, powerful computing resources, and innovative algorithms. AI has the potential to transform various domains of human activity, such as health, education, entertainment, business, and security. One of the most exciting and promising areas of AI is Generative AI, which is the ability to create *new and original content, such as text, images, music, code, and more, based on some input or guidance.*

Gamma

It is an AI-powered tool that allows you to quickly create beautifuland interactive presentations, reports, and web pages. Think of it as a streamlined alternative to traditional slide-based presentations, designed to make presenting information engaging and clear. It offers an array of tools and features to transform presentations into visually engaging experiences, ensuring maximum impact and effective communication.

AI Revolutionizing Education: From Classrooms to Research Labs

- Teaching: PowerPoint generation, lesson customization, and intelligent learning resources.
- Learning: Personalized learning paths, immediate feedback, and realtime support for diverse learners.
- Evaluation: Automated grading, insightful analytics, and identifying areas for improvement.
- Research and Analysis: Uncovering hidden patterns in educational data, and predicting trends.
- Mining vast datasets: Imagine AI quickly identifying trends, analysing research papers, and suggesting relevant resources, accelerating discovery, and saving researchers' valuable time.
- Automated citation checking and plagiarism detection: Ensure the integrity of research with AI-powered tools that streamline these tedious tasks.
- Personalized writing assistants: Enhance research papers with AI tools that provide grammar suggestions, improve clarity, and ensure academic style consistency. The integration of AI into education represents a significant step forward, demonstrating educators' commitment to innovation. Let's work together to leverage the power of AI to create a future where educators are empowered, learners are deeply engaged, and cultivates a lifelong passion for learning.

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Why Education Needs AI Integration

Education is a fundamental human right and a key driving force for social and economic development. However, education also faces many challenges: such as access, quality, equity, relevance, innovation, identifying diverse student needs, rapidly shifting information landscapes, and a pressing demand for 21st-century skills. AI is poised to reshape the way we teach, learn, and conduct research.

AI isn't about robots seizing control of classrooms; it's about sophisticated algorithms and techniques that emulate human intelligence. AI can be seen as an extensive digital toolkit that enables:

- Personalize Instruction: Imagine an AI tutor adapting to a student's learning pace, tailor learning paths to individual needs, identify knowledge gaps, and provide targeted feedback to each learner, accelerating progress towards learning goals.
- Automate Tasks: Streamline lesson planning, grade assessments, and generate engaging learning content.
- Analyses Data: Uncover patterns, predict trends, and reveal valuable insights in educational data.
- Ignites Creativity: Generate original text, images, code, and other content, unleashing student ingenuity.

  Source: https://gamma.app
- Tome: It is a website that offers an artificial intelligence (AI) tool for creating personalized teaching materials for various subjects and topics. Use the Tome application to plan your lessons, create exercises and worksheets, and generate quizzes and tests with the help of AI. Also use the Tome app to access and modify pre-made content from a library of over 500 exercises and worksheets.(Source: https://tome.app/)
- Beautiful.ai: Beautiful.ai is a cloud-based presentation platform that leverages artificial intelligence(AI) to simplify and streamline the presentation creation process. It aims to help users create visually appealing and professional-looking presentations quickly and easily.

AI enhances the teaching process by:

- **Personalizing Instruction:** Tools like Knewton or Smart Sparrow adapt content to individual student needs.
- **Automated Grading:** Tools such as Gradescope use AI to evaluate assignments and quizzes.
- **Virtual Teaching Assistants:** Chatbots like Jill Watson at Georgia Tech assist in answering student queries 24/7.
- **Content Creation:** AI tools such as Quizlet or ChatGPT help educators generate quizzes, summaries, and explanations.

AI In Teaching Presentation Tools

- Decktopus: https://www.decktopus.com/
- ZohoShow: https://www.zoho.com/show/
- Visme: https://www.visme.co/

Artificial Intelligence in Learning

AI empowers learners by:

- **Adaptive Learning Platforms:** Duolingo, Coursera, and Khan Academy use AI to tailor learning paths.
- **Intelligent Tutoring Systems:** AI systems like Socratic or Carnegie Learning guide students step-by-step.
- **Language and Skill Learning:** Apps like ELSA Speak and LinkedIn Learning employ AI for real-time feedback.
- **Gamification and Engagement:** AI helps create interactive learning environments to boost motivation.

Artificial Intelligence in Learning LLM Tools

- Anthropic Claude: https://www.anthropic.com/claude
- Perplexity : https://www.perplexity.ai/
- Talkpal: https://talkpal.ai/

Text – to – Video Generation Tools

- Kapwing: https://www.kapwing.com/ai/text-to-video
- Sora: https://openai.com/sora
- Lumen5 : https://lumen5.com/

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- Animaker: https://www.animaker.com/
- Renderforest: https://www.renderforest.com/

Text – to – Image Generation Tools

- PhotoSonic: https://photosonic.pro/
- Jasper: https://www.jasper.ai/art
- DaVinci : https://davinci.ai/
- Gencraft: https://gencraft.com/
- Wepik: https://wepik.com/ai

Artificial Intelligence in Research

AI is transforming the research landscape through:

- Literature Review Automation: Tools like Iris.ai and Connected Papers summarize and visualize related work.
- Plagiarism Detection: AI-based tools like Turnitin ensure research originality.
- Data Analysis and Prediction: AI tools such as SPSS Modeler, RapidMiner, and Google AutoML help in processing large datasets.
- Academic Writing Support: Tools like Grammarly, Writefull, and ChatGPT assist in language refinement and content generation.

Artificial Intelligence in Research Analysis Tools:

- Elicit: https://elicit.com/
- OpenRead: https://www.openread.academy/
- Semantic Scholar: https://www.semanticscholar.org/
- Jenni: https://jenni.ai/
- ZeroGPT: https://www.zerogpt.com/
- Litmaps: https://www.litmaps.com/
- Copyleaks: https://copyleaks.com/
- ChatDOC: https://chatdoc.com/
- SpinBot: https://spinbot.com/

Artificial Intelligence in Evaluation:

- Forms.app: https://forms.app/
- BlockSurvey: https://blocksurvey.io/
- Zonka: https://www.zonkafeedback.com/
- QuestionPro: https://www.questionpro.com/in/

Advantages of AI in Improving Academic Support Teaching, Learning and Research :

- Personalized Learning : AI-powered tools can analyze student data to identify individual learning needs and provide tailored support, including virtual tutoring, customized content, and adaptive learning platforms.
- Automated Tasks : AI can automate repetitive tasks like grading, lesson planning, and administrative work, freeing up educators' time for more focused teaching and student interaction.
- Enhanced Research : AI can assist with literature reviews, data analysis, and research writing, enabling more efficient and in-depth research.
- Accessibility : AI tools can be integrated with assistive technologies to support students with disabilities, providing personalized learning experiences.
- Increased Engagement: AI-powered gamification features can make learning more engaging and motivating for students. Increases accessibility and inclusivity, Enhances efficiency and productivity. Supports lifelong and self-paced learning. Reduces the cognitive load for educators and researchers.

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AI in Teaching, Learning and Research

Ethics of Artificial Intelligence:

The rapid rise in artificial intelligence (AI) has created many opportunities globally. However, these rapid changes also raise profound ethical concerns. These arise from the potential AI systems have to embed biases, contribute to climate degradation, threaten human rights and more. Such risks associated with AI have already begun to compound on top of existing inequalities, resulting in further harm to already marginalized groups. To correct this, the Recommendation on the Ethics of Artificial Intelligence was adopted by acclamation by 193 Member States in 2021. Global AI Ethics and Governance Observatory

Emerging Trends in AI in TLR:

- Text and data mining: The ability of AI to mine data and write language is revolutionizing research support. Libraries can use AI technologies to analyze large datasets more quickly and thoroughly. Accelerated trend analysis, data extraction, and literature reviews help researchers and greatly improve the productivity of the research process.
- AI-assisted information literacy programs: Libraries may use AI to create interactive and adaptable information literacy programs since they are centers of learning. These customized learning-style-based programs offer users one-on-one assistance in navigating the information landscape. AI-powered lessons help users develop their critical thinking abilities so they may successfully traverse the complexity of information in the digital era.
    - **Digital Divide:** Not all institutions or learners have equal access to AI tools.
    - **Ethical Concerns:** Issues related to data privacy, algorithmic bias, and plagiarism.
    - **Training Needs:** Faculty and students require proper training to effectively use AI tools.
    - **Dependency Risks:** Overreliance on AI may reduce critical thinking and analytical skills.

Conclusion

Artificial Intelligence is a powerful enabler in the education sector teaching, learning and research ecosystem. Ensuring equitable access, digital literacy, and ethical usage is essential for maximizing its benefits in Teaching, Learning, and Research (TLR).Use of AI systems and tools must be safe and effective for students. They must include algorithmic discrimination protections, protect data privacy, provide notice and explanation, and provide a recourse to humans when problems arise. The people most affected by the use of AI in education must be part of the development of the AI model, system, or tool, even if this slows the pace of adoption.

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REVISITING CLASSICAL INTELLECTUAL THOUGHT IN THE DIGITAL AGE: FRANCIS BACON, SAMUEL JOHNSON, AND THE TRANSFORMATIVE EVOLUTION OF ACADEMIC LIBRARIES

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ABSTRACT

The rapid integration of emerging technologies has significantly transformed academic libraries, redefining how knowledge is stored, accessed, and utilized. Despite these changes, the fundamental philosophy of libraries as centers for intellectual inquiry, language development, and scholarly engagement remains rooted in classical thought. This paper examines the enduring relevance of Francis Bacon and Samuel Johnson in shaping foundational concepts of knowledge organization and linguistic rigor, and explores how their ideas inform contemporary digital library practices. Bacon's advocacy for systematic learning and empirical investigation, alongside Johnson's emphasis on disciplined engagement with texts and language precision, provide enduring frameworks for the design and operation of technology- driven academic libraries. The study highlights how digital tools, including AI- assisted search systems, digital repositories, online dictionaries, and virtual learning platforms, operationalize these classical principles, enhancing access, critical thinking, and interdisciplinary scholarship. The findings suggest that emerging technologies extend rather than replace traditional library ideals, enabling academic libraries to sustain their educational mission while adapting to the digital era.

Keywords: *Academic Libraries, Emerging Technologies, Francis Bacon, Samuel Johnson, Knowledge Organization, Language Development, Digital Scholarship*

Introduction

Academic libraries have historically served as the backbone of intellectual development in educational institutions, functioning not merely as repositories of books, but as dynamic centers for knowledge creation, dissemination, and critical inquiry (Shera, 1972). From the ancient repositories of Alexandria and the medieval monastic libraries to the Renaissance humanist collections, libraries have adapted continuously to the changing needs of scholarship, reflecting broader societal and cultural transformations. In the twenty-first century, technological advancements have catalyzed another profound transformation in the academic library, with emerging technologies such as artificial intelligence (AI), digital repositories, electronic databases, and virtual learning platforms redefining how information is accessed, processed, and utilized (Lancaster, 1995).

Despite these technological developments, the essential philosophy underlying academic libraries remains consistent. Libraries continue to promote intellectual inquiry, facilitate language development, and support scholarly communication—principles that were articulated centuries ago by influential thinkers such as Francis Bacon and Samuel Johnson. Bacon's advocacy for structured knowledge acquisition and empirical inquiry, coupled with Johnson's insistence on linguistic precision and disciplined engagement with texts, provides a philosophical foundation that resonates strongly with contemporary academic library practices.

This study explores how the intellectual contributions of Bacon and Johnson continue to shape modern academic librarianship in the digital age. It examines how classical ideas about knowledge organization, language learning, and scholarly discipline inform the integration of emerging technologies in library practices. By situating technological innovation within a classical intellectual framework, the paper argues that digital transformations extend rather than replace the core humanistic and scholarly mission of academic libraries.

Review of Literature

The evolution of academic libraries has been a key focus in library and information science research, particularly concerning technological adaptation and innovation. Lancaster (1995) emphasized that the transition from print-based libraries to electronic and digital systems fundamentally alters information access and storage mechanisms. However, the essential role of libraries—as mediators of knowledge, facilitators of learning, and custodians of intellectual heritage—remains unchanged. Similarly, Shera (1972) explored the philosophical foundations of librarianship, arguing that libraries should act as educational intermediaries, providing structured access to knowledge and promoting intellectual engagement among users.

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Ranganathan's (1931) seminal work, The Five Laws of Library Science, continues to influence contemporary library practices, emphasizing that libraries must focus on user needs, efficient organization of resources, and accessibility. These principles resonate with Baconian ideas of systematic knowledge and Johnsonian emphasis on linguistic and intellectual rigor. More recent studies on digital libraries highlight the transformative role of emerging technologies in shaping research practices and learning experiences. Digital repositories, AI-powered search tools, and virtual learning environments have expanded scholarly access to resources, promoted interdisciplinary research, and facilitated linguistic analysis at scales previously unimaginable (Lancaster, 1995).

However, much of the literature on digital library technologies focuses on technical implementation rather than philosophical grounding. There is a relative paucity of research connecting contemporary technological practices with classical intellectual traditions. By revisiting the contributions of Bacon and Johnson, this paper fills a gap in the literature, highlighting the enduring relevance of classical ideas in the design and operation of technology-driven academic libraries.

Research Problem

The proliferation of digital technologies in academic libraries presents both opportunities and challenges. While AI, digital repositories, and immersive learning platforms have significantly enhanced information accessibility, personalization, and research efficiency, there is a growing concern that these technological innovations may inadvertently weaken the humanistic foundations of library education. Specifically, the emphasis on speed, automation, and algorithm-driven retrieval could compromise deep engagement with texts, linguistic precision, and critical reasoning— values central to classical library ideals (Shera, 1972).

The central research problem addressed in this study is whether the adoption of emerging technologies represents a break from classical intellectual principles or whether these technologies can be understood as extensions of those principles. By examining the contributions of Francis Bacon and Samuel Johnson, the study seeks to clarify how their ideas about systematic knowledge and linguistic rigor can inform contemporary digital library practices.

Research Hypothesis

This study is guided by the hypothesis that emerging technologies in academic libraries do not replace classical intellectual principles but rather operationalize and extend them. Bacon's focus on empirical inquiry, structured knowledge acquisition, and the practical application of learning provides a philosophical framework for modern information organization systems (Bacon, 1605; Bacon, 1620). Similarly, Johnson's emphasis on disciplined reading, linguistic precision, and critical textual engagement offers a guiding principle for developing digital tools that promote meaningful interaction with language and scholarly texts (Johnson, 1755). Consequently, digital innovations, when thoughtfully integrated, reinforce the educational mission of libraries rather than diminishing it.

Francis Bacon: Systematic Knowledge and Modern Libraries

Bacon's Philosophy of Knowledge

Francis Bacon (1561–1626) is widely regarded as a pioneer of modern scientific methodology. His philosophical works, particularly The Advancement of Learning (1605) and Novum Organum (1620), challenged the prevailing scholastic approaches of his time, advocating instead for systematic, empirical methods of inquiry. Bacon argued that knowledge should not remain abstract but be applied for societal improvement. He stressed that human understanding could be advanced through careful observation, experimentation, and the logical organization of information (Bacon, 1620).

Baconian Principles in Library Practices

Bacon viewed reading and structured study as essential to intellectual development, famously asserting that "reading maketh a full man" (Bacon, 1605). In his vision, libraries functioned as critical instruments for preserving knowledge, organizing it systematically, and facilitating its practical application. These principles underpin many contemporary library practices, including classification systems, metadata organization, indexing, and cataloging (Ranganathan, 1931). By providing structured access to information, libraries create environments conducive to intellectual growth, critical inquiry, and the systematic accumulation of knowledge.

Digital Technologies and Baconian Thought

Contemporary academic libraries operationalize Baconian principles through technological innovation:

- Digital catalogues and metadata systems enable precise organization of knowledge, supporting efficient retrieval and research planning (Lancaster, 1995).
- Institutional repositories and online databases facilitate collective knowledge accumulation, ensuring that scholarly outputs are widely accessible and preserved over time (Shera, 1972).

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- Artificial intelligence and data analytics support evidence-based research by providing advanced search capabilities, personalized recommendations, and trend analysis, aligning with Bacon's vision of practical, systematic knowledge application.

In these ways, digital libraries embody the Baconian ideal of structured, purposeful, and accessible knowledge.

Samuel Johnson: Language, Scholarship, and Libraries

Johnson's Contribution to Language and Knowledge

Samuel Johnson (1709–1784) made enduring contributions to English language studies and literary scholarship. His Dictionary of the English Language (1755) was a monumental achievement, establishing a standard for spelling, definitions, and usage. Johnson viewed language as foundational to rational thought, moral reasoning, and effective communication. His work underscored the importance of disciplined engagement with texts, careful observation of usage, and critical interpretation (Johnson, 1755).

Libraries as Spaces for Linguistic Development

Johnson's scholarly work relied extensively on library resources. His careful reading of literary texts illustrates how libraries functioned as sites for intellectual and linguistic development. By facilitating access to diverse texts, libraries support:

- Vocabulary and semantic development through exposure to varied literary examples.
- Critical reading and analytical skills, fostering judgment and interpretive ability.
- Preservation of linguistic and cultural traditions, ensuring continuity of knowledge across generations (Johnson, 1755).

Johnson's Influence on Digital Libraries

Digital libraries extend Johnsonian ideals by enhancing access to linguistic and literary resources:

- Online dictionaries and language-learning platforms enable global, immediate access to language tools.
- Textual corpora facilitate large-scale analysis of linguistic patterns and historical language usage.
- Digital humanities platforms allow researchers to perform computational textual analysis, tracing stylistic trends, semantic networks, and historical language evolution (Lancaster, 1995).

These tools amplify Johnson's commitment to language, scholarship, and disciplined reading in the context of digital research environments.

Academic Libraries as Experimental Spaces for Knowledge and Language

Bacon and Johnson collectively envision the library as an experimental environment where knowledge is actively constructed and language proficiency is cultivated. Bacon emphasizes inquiry, observation, and systematic learning, while Johnson underscores precision, critical interpretation, and linguistic clarity. Modern academic libraries operationalize these principles through:

- Multimedia resources and interactive platforms that support diverse learning styles and disciplines.
- AI-assisted research tools that enable deeper engagement with texts and datasets.
- Support for interdisciplinary, multilingual, and collaborative research, fostering intellectual experimentation (Shera, 1972).

By integrating these approaches, libraries become dynamic laboratories for knowledge creation and language mastery.

Impact of Emerging Technologies

Emerging technologies have transformed the functional and operational dimensions of academic libraries:

- Digital libraries provide continuous, remote access to vast collections of texts, databases, and multimedia resources (Lancaster, 1995).
- AI-driven information retrieval systems enhance research efficiency and enable personalized study experiences.
- Open-access institutional repositories promote the dissemination and preservation of scholarly outputs.
- Virtual and augmented reality tools offer immersive learning experiences that extend beyond traditional text-based study (Shera, 1972).

Despite these technological transformations, the educational mission of libraries remains grounded in classical principles: supporting systematic knowledge acquisition, fostering linguistic precision, and cultivating critical thinking.

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Balancing Technology with Humanistic Values

One of the key challenges for modern academic libraries is maintaining a balance between technological efficiency and humanistic education. The sheer volume of digital information and the speed of automated retrieval can encourage superficial engagement with texts. Bacon's focus on purposeful, structured knowledge and Johnson's emphasis on disciplined reading remind librarians that technology should serve learning, not dominate it (Bacon, 1605; Johnson, 1755).

Strategies to balance technology and humanistic values include:

- Promoting information literacy, critical evaluation, and ethical research practices.
- Supporting language competence and interpretive skills through curated digital resources.
- Ensuring inclusive access so that technological tools serve diverse learner populations (Ranganathan, 1931).

Through thoughtful integration of technology and classical ideals, libraries can cultivate deeper intellectual engagement.

Implications for Contemporary Academic Librarianship

The philosophical legacies of Bacon and Johnson provide guiding principles for contemporary librarianship:

- User-centered digital services improve accessibility while supporting effective research and learning (Lancaster, 1995).
- Information literacy programs strengthen critical thinking, research skills, and language proficiency (Shera, 1972).
- Upholding scholarly rigor ensures that emerging technologies enhance intellectual development rather than undermine it (Bacon, 1620; Johnson, 1755).

By integrating classical frameworks with technological innovation, libraries can fulfill their educational mission and remain central to intellectual life in the digital age.

Conclusion

The intellectual contributions of Francis Bacon and Samuel Johnson continue to shape academic librarianship, offering enduring frameworks for knowledge organization, language development, and scholarly rigor. Emerging technologies do not replace these classical ideals; rather, they operationalize and extend them, enabling libraries to provide systematic access to information, support linguistic and critical skills, and foster interdisciplinary scholarship.

By integrating technological innovation with humanistic values, academic libraries remain vital centers of learning, research, and cultural transmission. In doing so, they honor their classical intellectual heritage while embracing the possibilities of the digital era, ensuring that libraries continue to cultivate knowledge, intellect, and language for generations to come.

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STUDY OF HRDC STAFFING PATTERN WITH SPECIAL REFERENCE OF LIBRARY

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ABSTRACT
This paper study the staffing pattern of HRDC with focus the post of the librarian. As per HRDC staffing pattern in 2012 guidelines the librarian post read under the non-teaching post and its mentioned librarian of technician. In the 2019 HRDC guidelines the librarian post is opt out and consider as a documentation assistant.

Keywords: *HRDC Staffing Pattern, Library*

Introduction

As per the UGC rules for minimum qualifications for recruitment of teachers and other academics in universities and colleges and the steps to be taken for maintaining high quality in higher education (30th June, 2010) and taking into consideration, the need for developing the teachers working in higher educational institutions, the ASCs (HRDC) have to be consolidated so that they give the desired outputs. For this purpose, a procedural evaluation of the results delivered by the present ASCs (HRDC) is necessitated to be assessed and thereby give suitable suggestions for the framing of policies to further the growth of quality of the staff development programs.

Review of Literature

Osinulu and Amusa, (2010) address library-related topics where innovation may be considered account. They talk about a range of topics related to quality assurance, including financial automation, information technology, staffing, facilities, and collections.

The study "Academic Staff Colleges: A Developing concept" was done in (1990) by Dhar, B.B. and Singh, T. They tried to explain the responsibilities and role of university and college professors in advancing the aims and purposes of academic staff colleges. By gathering feedback regarding the course content of the four components on the final day of the inaugural Orientation program hosted by B.H.U., they also conducted a study of the relevance of the orientation program for university teachers.

Satrughna Behera, (2009) it was decided that the academic staff college should become a permanent institution rather than having funding renewed every five years as part of a project, given the significance that the Xth plan UGC guideline places on it. To close the gap and end the current contradiction between the "elite" colleges in large metropolitan settings and the money-starved education complex at the "periphery" of the Indian educational system, integrating ASCs into the educational process should be a priority.

Objectives

- To study the structure of staffing pattern HRDC
- Compare guidelines of staffing pattern of HRDC 2012 and 2019
- To focus the post of librarian

Administrative Structure of HRDC

(HRDC) is an independent entity sponsored through UGC. It is an inter university center developing the teachers of colleges and universities of the states and is open to the teachers of other states. It is an autonomous independent entity, functioning within the guidelines of UGC. UGC periodically (once in 5 years) controls and reviews the operation of the centers. UGC may also make an evaluation of the centers in between and if finds any lacunae can dismiss any center for acceptable reasons.

HRDC Advisory Committee

Advisory body for every ASC (HRDC) which has representation from the University and colleges. Decisions concerning theday to day working, academic and monetary aspects are advised by the committee members. The advisory committee's chairmanis the Vice Chancellor of the concerned University where the ASC (HRDC) is located. Following is the pattern of the Advisory committee:

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Vice Chancellor of the University where the ASC (HRDC) is located.

- 1 Vice Chancellor of another University
- 1 nominee of the UGC
- 2 Directors (HRDC)
- 1 eminent Professor
- 2 Heads of The University's departments
- 2 Principals of the affiliated colleges (of which 1 is from a private college)
- Commissioner (Director) of Higher education of the respective state (Union territory)
- Director of ASC (HRDC)

Position of Librarian

The position of a librarian in HRDC (Human Resource Development Centers) can be either a regular post or a temporary post, depending on the center's policy and the availability of funds.

If the HRDC has a requirement for a full-time librarian, they may fill the post through a regular appointment process. The regular post offers job security, benefits, and opportunity for career growth and development. The regular post may also involve a probationary period that the candidate has to complete before getting a permanent status.

On the other hand, if the HRDC has a temporary requirement for a librarian due to a specific project or activity, they may fill the post through a temporary appointment process. The temporary post offers a fixed-term contract and remuneration as per the terms of the contract. The temporary post does not offer job security, benefits, or opportunity for career growth and development.

Therefore, it is crucial to check the job advertisement or contact the HRDC to confirm whether the librarian post is a regular or temporary post before applying for the position.

Staffing Pattern of HRDC 2012 and 2019 Guidelines

Staffing Patter Guidelines of HRDC 2012	Staffing Patter Guidelines of HRDC 2019
I) Academic Faculty In teaching faculty there are Professor, Associate Professor, Assistant Professor II) Non-teaching staff Following are the non-teaching staff: • Section Officer • Senior Assistant • Junior Assistant • Computer Assistant • Librarian or Technician • Steno typist / Computer operator • Peon • Hostel Attendant [if the ASC (HRDC) has its own hostel.	I) Academic Faculty In teaching faculty there are Professor, Associate Professor, Assistant Professor II) Non-teaching staff Following are the non-teaching staff: • Technical Officer: 1 (ICT applications, maintenance and training). • Section Officer: 1 • Sr. Assistant: 1 • Jr. Assistant: 1 • Documentation Assistant (at the level of Professional Assistant):1 • Steno-typist/Computer Operator: 1 • Peon/Multi-Tasking Staff (at the level of Group-C): 1 • One hostel attendant is available for ASCs with separate lodging

Conclusions & Suggestions

The post of librarian is under teaching post but in these HRDC librarian posts come under non-teaching post or it's called as administrative post. In the Guidelines of HRDC 2019 the post of the librarian is not seen. Otherwise, it is read under technical assistant or documentation assistant (at the level of Professional Assistant) in the guidelines for Academic Staff College (2007-2012), in that staffing pattern the post of librarian or technician is under the non-teaching post. As per University Grant Commission the post of the librarian is as a teaching post.The further research can study how to make guidelines for

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the staffing pattern and having a clear post of librarian.All the HRDC have appointed a regular librarian for the said post and this post is considered under the teaching post.

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LEADING CHANGE FOR DIGITAL TRANSFORMATION IN ACADEMIC LIBRARIES: STRATEGIES AND CHALLENGES

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ABSTRACT

Digital transformation in academic libraries is a complex organizational change that extends beyond technology deployment. Successful transformation depends on effective change management practices encompassing leadership, human capital development, culture, and stakeholder engagement. By adopting a strategic change management framework, academic libraries can sustainably navigate digital challenges and leverage emerging opportunities in higher education. Case studies from India and abroad reveal that libraries that manage change strategically emerge as central partners in higher education and research. Sustainable digital transformation requires continuous learning, adaptive leadership, and alignment with institutional goals.

Keywords: *Digital Transformation, Academic Libraries,*

Introduction

Academic libraries have traditionally served as repositories of printed knowledge, supporting teaching, learning, and research. They are undergoing a paradigm shift due to rapid advancements in digital technologies such as artificial intelligence, cloud computing, automation, and open-access platforms. Institutional repositories, mobile platforms, and data analytics has basically altered the nature of information access and scholarly communication. This transition from traditional library systems to digitally enabled knowledge ecosystems require not only technological adoption but also effective change management strategies. Digital transformation in academic libraries is fundamentally an organizational change process involving people, processes, culture, and leadership. Consequently, academic libraries are transforming into digital knowledge hubs that facilitate research, innovation, and lifelong learning. Despite widespread availability of digital tools, many libraries struggle with implementation due to resistance to change, skill gaps, budget constraints, and organizational inertia. This highlights that digital transformation is not a purely technological exercise, but a leadership-driven change management process. In India, initiatives such as Digital India, National Education Policy (NEP) 2020, and large-scale library consortia have accelerated digital adoption, making leadership and change management more critical than ever. This paper explores how academic libraries lead and manage change during digital transformation, using diverse case studies to demonstrate strategies, challenges, and outcomes.

Review of Literature

Digital transformation in academic libraries is a response to technological advancement, evolving user expectations, and changes in scholarly communication. Xu and Du (2024) define digital transformation in libraries as a holistic process involving technological innovation, organizational restructuring, and service redesign. Unlike earlier digitization efforts that focused on converting print resources into electronic formats, contemporary digital transformation emphasizes user-centered platforms, data-driven services, and integration with institutional research ecosystems.

Tenopir et al. (2023) highlight that academic libraries are increasingly supporting research data management, open science initiatives, and digital scholarship, positioning libraries as active partners in research rather than passive service providers.

Corrall, Kennan, and Afzal (2024) argue that digital transformation has expanded the strategic role of libraries, requiring alignment with institutional missions and long-term academic goals.

Studies in the Indian context reveal that national initiatives such as the National Digital Library of India (NDLI), Shodhganga, and e-Shodh Sindhu have significantly accelerated digital adoption in higher education libraries (INFLIBNET, 2023). However, scholars note that technological infrastructure alone does not guarantee effective transformation without organizational readiness and leadership support (Hooda & Gupta, 2024).

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Change management literature provides a strong theoretical foundation for understanding digital transformation in libraries. Lewin's three-stage model (Unfreeze–Change–Refreeze) and Kotter's eight-step change framework remain widely applied in organizational transformation studies. Kotter (2022) emphasizes that successful change requires leadership-driven vision, employee engagement, and institutionalization of new practices.

Bryson (2023) argues that public and nonprofit organizations, including academic libraries, face unique challenges in managing change due to bureaucratic structures, resource constraints, and stakeholder diversity. This makes strategic planning and leadership intervention critical for sustainable transformation. In the context of libraries, Rowley and Hartley (2023) observe that resistance to change often arises from cultural rigidity, fear of role displacement, and skill gaps rather than opposition to technology itself. Studies consistently show that participative decision-making, transparent communication, and continuous training reduce resistance and foster acceptance of digital initiatives.

Leadership has emerged as a central theme in digital transformation research. Corrall et al. (2024) stress that library leaders must adopt transformational and adaptive leadership styles to navigate digital complexity. Transformational leadership encourages innovation, experimentation, and professional development, enabling staff to adapt to changing roles. IFLA (2023) underscores that leadership in digital libraries is no longer limited to administrative control but extends to advocacy, collaboration, and capacity building. Library leaders are expected to act as change agents who bridge technology, academic stakeholders, and policy frameworks. Indian studies reveal that institutional leadership plays a decisive role in translating national digital policies into actionable strategies at the local level (UGC, 2023). Where leadership commitment is weak, digital initiatives often remain underutilized.

Digital transformation necessitates continuous upskilling of library professionals. Tenopir et al. (2023) identify competencies such as data literacy, digital curation, cybersecurity awareness, and research analytics as critical for modern librarianship. Similarly, DeLone and McLean (2023) emphasize the need to align human capabilities with information system success. Hooda and Gupta (2024) highlight that inadequate training is a major barrier in Indian academic libraries, particularly in rural and government institutions. Professional development programs, peer learning, and collaboration with IT departments have been shown to enhance staff confidence and reduce resistance to digital change.

Government policies have played a pivotal role in shaping digital transformation in Indian academic libraries. The National Education Policy (NEP) 2020 emphasizes technology-enabled education, open access, and digital repositories as key drivers of academic excellence (Ministry of Education, 2020).

Initiatives such as ONOS aim to democratize access to scholarly resources by reducing cost disparities across institutions. Studies note that consortium-based models improve efficiency and equity but require strong coordination and institutional adaptation (INFLIBNET, 2023).

UGC (2023) guidelines on digital repositories and open access further institutionalize digital practices, making compliance mandatory. However, mandated change often encounters initial resistance unless accompanied by training and awareness programs. The COVID-19 pandemic has been recognized as a catalyst for rapid digital transformation. OECD (2023) reports that academic libraries globally transitioned to virtual services, remote access platforms, and online user engagement within a short period. Research indicates that crisis-induced change bypasses prolonged resistance due to urgency but creates sustainability challenges once normalcy returns (Xu & Du, 2024). Libraries that institutionalized emergency practices through policy revisions and staff training achieved more durable outcomes.

Objectives of the Study

The objectives of the study are:

- To examine digital transformation in academic libraries from a change management perspective.
- To analyse leadership strategies adopted during digital transitions.
- To identify challenges faced by academic libraries in managing digital change.
- To study national, institutional, case examples of digital transformation.
- To suggest strategic measures for sustainable digital transformation in academic libraries.

Research Methodology

The study adopts a qualitative and descriptive research approach based on secondary data. Data were collected from scholarly journals, policy documents, institutional reports, conference proceedings, and official portals of national and international library organizations. A case study method is used to analyses leadership-driven digital transformation across different contexts. The analysis is conceptual and interpretative, supported by illustrative case studies to provide practical insights.

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Digital Transformation in Academic Libraries as an Organizational Change Process

Digital transformation in academic libraries should be understood as a structured organizational change process rather than a standalone technological intervention. Change management theories such as Lewin's Unfreeze–Change–Refreeze model and Kotter's leadership-oriented framework provide valuable insights into how libraries transition from traditional to digital environments.

In the "unfreezing" stage, libraries challenge existing practices such as print-based workflows and restricted access. The "change" stage involves implementing digital systems, redefining roles, and developing new competencies. Finally, the "refreezing" stage institutionalizes digital practices through policies, training, and cultural adaptation. Viewing digital transformation through this lens highlights the centrality of leadership, communication, and human resource development.

Change management involves preparing, supporting, and enabling individuals and institutions to transition from existing practices to new systems. Models such as Lewin's Change Model and Kotter's Change Leadership Framework emphasize leadership vision, communication, participation, and institutionalization of change. In libraries, change management addresses cultural resistance, role redefinition, and skill development.

Libraries face resistance due to fear of job displacement, lack of digital skills, budget constraints, and cultural rigidity. Therefore, managing change becomes critical to ensure smooth digital transition and long-term sustainability.

Digital transformation in academic libraries includes automation, digital repositories, remote access services, research data management, and user-centric digital platforms. Effective transformation requires alignment between technology, people, and processes.

Drivers of Digital Transformation in Academic Libraries

- Growth of digital learning and research ecosystems
- Increasing demand for remote and 24/7 access to information
- Expansion of open access resources and institutional repositories
- Integration of AI-based discovery tools and automation
- Government initiatives such as Digital India and National Education Policy (NEP) 2020
- Rising expectations for user-centered and data-driven services

Strategic Dimensions of Change Management

Leadership and Vision

Leadership plays a pivotal role in guiding academic libraries through digital change. Effective leaders articulate a clear digital vision, align transformation initiatives with institutional goals, and motivate staff to adopt new roles. Transformational and participative leadership styles are particularly effective in fostering innovation and reducing resistance. Across the analyzed cases, leadership strategies included continuous capacity building, participative decision-making, strategic technology adoption, and sustained stakeholder engagement. Library leaders acted not only as administrators but also as change agents, facilitators, and advocates for digital innovation.

Human Resource Development

Digital transformation demands new competencies such as data literacy, digital curation, cybersecurity awareness, and technology management. Continuous training, reskilling, and professional development programs are essential to overcome skill gaps among library professionals.

Organizational Culture

A culture that supports adaptability, innovation, and learning is crucial. Change management strategies should focus on reducing resistance by involving staff in decision-making, fostering teamwork, and promoting a positive attitude toward technology adoption.

Technology and Process Reengineering

Introducing digital systems such as cloud-based library management systems, RFID, AI-driven cataloging, and virtual reference services requires reengineering existing workflows. Strategic planning ensures that technology adoption aligns with user needs and institutional priorities.

Communication and Stakeholder Engagement

Transparent communication with faculty, students, administrators, and policymakers is vital. Regular feedback mechanisms help libraries refine digital services and increase user acceptance.

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Challenges in Managing Digital Change

Despite significant progress, academic libraries face multiple challenges in managing digital transformation. These challenges include resistance to change among staff, inadequate funding and infrastructure, digital skill gaps, cybersecurity and data privacy concerns, copyright and licensing complexities, and persistent digital divides among users. Importantly, resistance is often cultural and psychological rather than technical, rooted in fear of role displacement and increased accountability. The study finds that these challenges can be effectively mitigated through transparent communication, continuous training, and inclusive leadership practices.

Opportunities and Outcomes

Effective change management enables academic libraries to:

- Enhance service quality and accessibility
- Improve research support and knowledge dissemination
- Strengthen institutional reputation
- Support interdisciplinary learning and innovation
- Transform libraries into **knowledge innovation hubs**

Conceptual Framework for Case Study Analysis

Digital transformation in academic libraries cannot be understood purely as a technological upgrade. It is a multi-dimensional organizational change process involving structural, cultural, and behavioural transformation. The Study applies a change management lens, drawing implicitly on Lewin's Change Model (Unfreeze–Change–Refreeze) and Kotter's leadership-oriented change principles, to analyze real-world digital transformation initiatives.

The selected case studies represent four distinct change pathways:

- Policy-led systemic change (ONOS)
- Vision-driven inclusive change (NDLI)
- Mandated compliance-based change (Shodhganga)
- Crisis-induced rapid change (COVID-19 digital transition)

Together, they provide a comprehensive understanding of how leadership strategies shape digital transformation outcomes in academic libraries.

Case Study 1: One Nation One Subscription (ONOS)
(A Model of Policy-Led Digital Transformation)

ONOS represents a policy-led national digital transformation initiative aimed at providing equitable access to international scholarly journals across Indian HEIs. Leadership at the national level centralized subscription negotiations through INFLIBNET, while institutional leaders facilitated local adoption. Before ONOS, access to international scholarly journals in India was highly uneven. Elite institutions could afford expensive subscriptions, while many government and rural colleges lacked access entirely. This created knowledge inequality and constrained research productivity. ONOS was conceptualized as a national-level intervention to address this structural imbalance through collective negotiation and centralized access.

ONOS exemplifies top-down strategic leadership, where policy direction originates at the national level but implementation occurs locally.

Key leadership actions included:

- **Vision articulation**: Positioning ONOS as a national research equity mission
- **Stakeholder alignment**: Coordinating UGC, INFLIBNET, publishers, and institutions
- **Role redefinition**: Librarians transitioned from procurement managers to research access facilitators
- **Infrastructure enablement**: Integration with institutional authentication systems

From a change management perspective, ONOS effectively "unfroze" traditional acquisition practices by questioning cost inefficiencies and inequitable access. ONOS demonstrates that policy-led change can be sustainable only when institutions internalize ownership of the reform.

Case Study 2: National Digital Library of India (NDLI)
(A Vision-Driven and Inclusive Change Model)

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NDLI was conceived to democratize access to learning resources across disciplines, languages, and learner categories. Unlike ONOS, NDLI focuses not only on higher education but also on lifelong learning and inclusivity.

NDLI exemplifies a vision-driven and inclusive digital change model.

NDLI's leadership model is collaborative and participative:

- A clear national vision aligned with *Digital India*
- Distributed content creation involving libraries and institutions
- Librarians empowered as digital curators and user educators

Leadership focused heavily on cultural change, encouraging libraries to see themselves as contributors to a shared national knowledge ecosystem. NDLI proves that vision-driven change supported by collaboration fosters deeper cultural acceptance. NDLI leadership adopted a capacity-building approach, offering tools, training, and technical support.

Case Study 3: Shodhganga – Institutional Repository Initiative
(Mandated Change with Cultural Resistance)

Shodhganga mandated electronic submission of theses, challenging long-standing academic traditions centered on print submission and restricted access.

Leadership relied on:

- Regulatory authority through UGC mandates
- Librarian training in repository management
- Faculty and scholar orientation programs

Shodhganga representing a compliance-based change model, effective but initially resistant. Mandated change becomes effective only when accompanied by trust-building and skill development. Mandated change requires trust-building, policy clarity, and skill development to overcome resistance. e-Shodh Sindhu functioned as a collaborative digital resource-sharing model, laying the foundation for ONOS. Consortium-based leadership enables scalable and cost-effective digital transformation.

Case Study 4: COVID-19–Induced Digital Transformation
(Crisis as a Catalyst for Change)

The pandemic forced immediate closure of physical libraries, leaving no alternative but digital service delivery.

Library leaders adopted:

- Rapid decision-making
- Temporary suspension of traditional workflows
- Emergency training for staff
- Experimentation with virtual services

This phase bypassed prolonged resistance due to urgency. Despite these challenges, leadership focused on learning-by-doing, accelerating digital maturity. Crisis-induced change can result in long-term transformation when leaders institutionalize learning.

Comparative Analysis of Case Studies

Dimension	ONOS	NDLI	Shodhganga	COVID-Induced Change
Nature of Change	Policy-led	Vision-led	Mandated	Crisis-driven
Leadership Level	National + Institutional	National	Institutional	Institutional
Resistance Level	Moderate	Low	High initially	High initially
Sustainability	High	High	High	Medium–High
Role of Librarians	Access facilitators	Digital curators	Research partners	Digital service enablers

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Case Study 5: KOHA Implementation in Indian Academic Libraries
(Technology-Driven Change at Institutional Level)

Many Indian universities and autonomous colleges transitioned from manual or proprietary library systems to KOHA (open-source Library Management System) to improve efficiency, reduce costs, and enhance digital services. Decision were taken by institutional leadership to adopt open-source technology. KOHA adoption shows that incremental, participative change reduces resistance and builds staff confidence. It Demonstrates how leadership decisions and staff training determine success of digital tools.

Case Study 6: RFID and Smart Library Initiatives in Central Universities
(Process Reengineering and Cultural Change)

Universities such as Delhi University, JNU, and IITs implemented RFID-based circulation and security systems to modernize library operations. Its Strategic vision to create self-service libraries Digital transformation succeeds when leadership redefines roles rather than eliminates them.

Case-Based Analysis of Digital Transformation Initiatives
To ground the analysis in real-world practice, the study examines diverse case studies representing different change pathways:

- Leadership clarity reduced resistance
- Training and communication were decisive factors
- Technology acted as an enabler, not the driver
- Libraries shifted from operational units to strategic academic partners
- Digital transformation must be strategically led, not technically managed
- Librarians need continuous upskilling and role redefinition
- Change management frameworks should guide digital initiatives
- Policy support must translate into institutional culture change

This detailed case analysis confirms that digital transformation in academic libraries is fundamentally a leadership-centric change process. Whether driven by policy, vision, mandate, or crisis, successful transformation depends on leaders' ability to manage people, align strategy, and institutionalize innovation. Academic libraries that adopt structured change management approaches will remain central to teaching, learning, and research in the digital age.

Findings of the Study

- Digital transformation is fundamentally a leadership-driven change process.
- Technology adoption alone does not ensure success.
- Capacity building and staff involvement reduce resistance and enhance acceptance.
- Policy support must be translated into institutional culture change.
- Libraries are evolving into knowledge innovation hubs.
- Change management frameworks improve the effectiveness and sustainability of digital initiatives.
- Librarians' roles are expanding from custodial functions to strategic academic partnership.
- Beyond flagship national initiatives, institutional and international case studies further demonstrate that leadership, rather than technology, is the decisive factor in managing digital transformation in academic libraries.

Strategic Measures for Sustainable Digital Transformation

- Based on the findings, the study suggests the following strategic measures:
- Formal adoption of change management frameworks in digital initiatives
- Continuous professional development and reskilling of library staff
- Participative leadership and inclusive governance structures
- Strategic use of open-source and cost-effective technologies
- Development of evaluation metrics to measure long-term impact
- Continuous communication and stakeholder engagement

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These measures ensure that digital transformation is not episodic but institutionalized and sustainable.

Conclusion

Digital transformation in academic libraries is a complex organizational change that extends beyond technology deployment. Successful transformation depends on effective change management practices encompassing leadership, human capital development, culture, and stakeholder engagement. By adopting a strategic change management framework, academic libraries can sustainably navigate digital challenges and leverage emerging opportunities in higher education. Case studies from India and abroad reveal that libraries that manage change strategically emerge as central partners in higher education and research. Sustainable digital transformation requires continuous learning, adaptive leadership, and alignment with institutional goals.

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CLOUD COMPUTING: AN OVERVIEW OF USING IN ACADEMIC LIBRARIES

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ABSTRACT
Cloud computing is a new technique of computing that is extensively used in today's industry is as well as society. It is also a new breed of service offered overview the internet, which has completely changed the way one can use the power of computers irrespective of geographical location. Cloud computing brings the revolutionary changes in the world of Information Communication Technology. It has brought in new avenues for organization and business to offer services using hardware failure or software installs or platform of third-party sources and its users to avoid locally hosting multiple servers, devices equipments, and upgrading and computability issues. For many organizations cloud computing can simplify process and save time and costs and work flows they have. This paper discusses the cloud computing definitions, historical backgrounds, characteristics service models and deployment of cloud services and overview of this technology, institutes advantages and disadvantages and the areas of an application of new generation libraries

Keywords: *Cloud Computing, Libraries Information Communication Technology, Models, SaaS, PaaS, IaaS.*

INTRODUCTION

Cloud Computing technology has grown very fast in the last few years in Information Technology sectors and shown its high growth rate. It has given access to its consumers and business to use applications without installation and access their personal files at any compilation with Internet access. Cloud computing is a practical approach to experience direct cost benefits and it has the potential to transform a data centre from a capital intensive set up a variable priced environment. There are many synonyms for cloud computing such as 'on – demand computing', 'grid computing', 'distributed computing', 'software as a service', 'information utilities', or 'automatic computing'. The internet as a platform and others.1 Cloud computing is used by almost those all who have accessed and connected to the internet on a regular basis. Whether they are using Google's Gmail, to ward processing or photo sharing or video sharing one can use products that live in the cloud. Which are secure, backed – up and accessible from any internet connection. The best example of this is G – mail, which is increasingly used by organization and individuals to run their e – mail services. Google Applications being free for educational institutions is widely used for running different applications, especially e – mail services which was earlier run using their own computer servers. Libraries are using computers for running services such as Integrated Library Management Software (ILMS), website, or portal, digital library or institutional repository etc., These are either maintained by parent organization's computer staff or Library staff.

CLOUD COMPUTING

The term 'cloud' is analogical to 'internet'. The term 'cloud computing' is based on cloud drawings used in the past to represent telephone networks and later to depict internet. With the use of cloud computing, any one can gain access at any time through any device, via the internet, to data and files which you have uploaded, or to software applications which you have uploaded, or to software applications which you need to use for personal or professional use. Cloud computing allows them to avoid locally hosting and operating multiple servers over an organizations networks and constantly dealing with hard ware failure, software installation, upgrades, back up and compatibility issues and also enables them to save cost.

According to Wikipedia the cloud computing refers "the delivery of computing as a service rather than a product, where by shared resources, software and information are provided to computers and other devices as a metered service over a network, typically the internet.2

The Christy & Carina3 of Gartner Group define cloud computing as 'a style of computing in which massively scalable and elastic IT – enabled capabilities are delivered as a service to external customers using internet technologies".

U.S. National Institute of Standards and Technology (NIST) defines cloud computing is a model for enabling convenient, on – demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management efforts or services provider interaction.

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CLOUD ARCHITECTURE

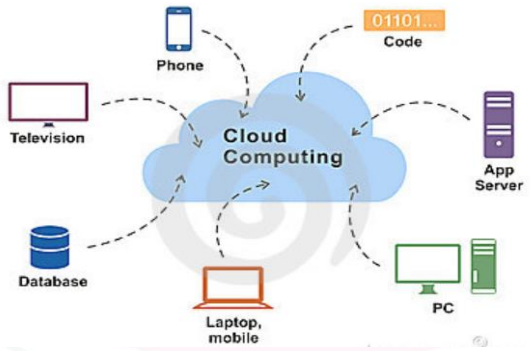
Cloud computing architecture consists two components "the front end" and "the back end". The front end comprises the client device and some applications are needed for accessing the cloud computing system. Back end refers which many encompass various computer matching data storage systems and servers. Groups of these clouds make a whole cloud computing system. A special type of software called "Middleware" is used to allow computers that are connected on the network to communicate with each other. Making copy of data is called redundancy and cloud computing service providers provide data redundancy.

HISTORICAL BACKGROUND OF CLOUD COMPUTING:

The origin of the term 'cloud computing' is obscure, it appears to derive from the practice of using drawings of stylized clouds to denote networks in diagrams of computing and communication systems. Cloud computing consists the key characters.

- Agility improves with users ability to re provisions of resources.
- Application Programming Interface (API) accessible to software with cloud software in the same way interaction between humans and compute.
- Cost is claimed to be reduced in a public cloud delivery model, capital expenditure is converted to operational expenditure.
- Virtualization technology allows servers and storage devices to be shared and utilization be increased. Applications can be easily migrated from one server to another server.
- Centralization of infrastructure in locating with lower casts. (real estate, electricity etc.,)
- Scalability and elasticity via dynamic ("on – demand") provisioning of resources on a fine grained.
- Security cloud improve due to centralization of data, increased security – focused resources etc, but concerns about loss of control over certain sensitive data, and the lack of security for stored kernels.
- Maintenance of cloud computing applications is easier, because they do not need to be installed on each user's computer and can be accessed from different places.

This cloud model promotes availability and is composed of five essential characteristics, there service models, and four deployment models.



TYPES OF CLOUD COMPUTING:

Cloud computing Information Technology model has wider meaning as it essential has three different types of services models. The following figure shows the three types of cloud services as three distinct models. They are

- SaaS – Software as a Service
- PaaS – Platform as a Service
- IaaS – Infrastructure as a Service

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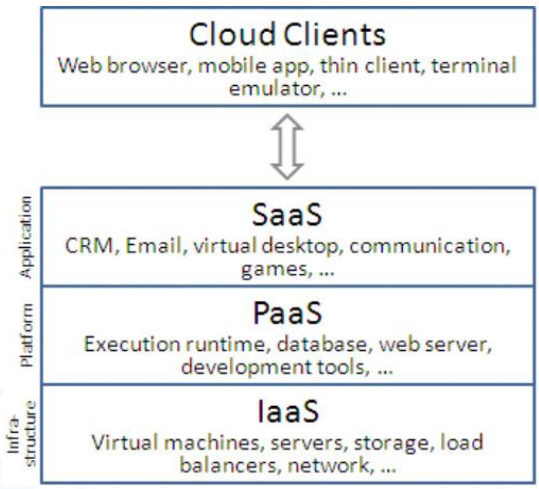

(a) SaaS – Software as a Service: In this model, a complete applications is offered to the customer, as a service on demand. A single instance of the service runs on the cloud & multiple end users are serviced. The delivery of business applications designed for a specific purpose. Software as a service comes in two distinct modes.

- **Simple multi – tenancy :** Each customer has its own resources that are segregated from those of other customers. It amounts to a relatively inefficient form of multi – tenancy.
- **Fine – grain multi – tenancy :** This offers same level of segregation, but more efficient. All resources are shared but customer data and access capabilities are segregated with the applications.
- Ex: Google Applications, Microsoft Office 365, Onlive, Marketo, Casengo sales force, Zoho and Trade card etc.,

(b) PaaS – Platform as a Service (PaaS) includes the delivery of more than just infrastructure. It delivers what you might call a solution stack and integrated set of software that provides every thing a developer needs to build an application – for both software development and runtime. Paas providers offers a predefined combination of os and application servers such as LAMP Platform (Linux, Apache, Mysqus and PHP), restricted J2EE, Ruby etc.,

Ex: Heroku, Force.com Engine yard, Mendix, openshift, Google Application Engine.

(c) IaaS – Infrastructure as a Service – (IaaS) provides basic storage and computing capabilities of computer hardware (servers, networking technology, storage and data centers space) as a service. It also include the delivery of operating system and virtualization technologies to merge the resources.

Ex: Amazon, Ec2, Go Grid, 3Tera, Azure services platform, Dyn, DNS, etc.

DEPLOYMENT MODELS

There are four different models of cloud computing.

- PUBLIC CLOUD – Public or external cloud is traditional cloud computing. It applications, storage, and other resources are made available to the general public a service provider. These services are free or offered on a pay – per – use model. The service providers like Amazon, AWS, Microsoft and Google own and operate infrastructure and access only via internet. (Direct connectivity not offered)
- COMMUNITY CLOUD – If several organizations have similar requirements and seek to share infrastructure to realize the benefits of cloud computing, then community cloud can be established. This is more expensive as compared to public cloud. This option offer high levels of privacy security and policy compliance.
- HYBRID CLOUD – Hybrid cloud means either two separate clouds joined together. (Public, Private, internal or external) or combination of virtualized cloud server instances together with real physical hardware.

  (i) Definition: Hybrid cloud is probably the use of physical hardware and virtualized cloud server instances together to provide a single common service. Two clouds have been joined together are more correctly called a "combined cloud". Hybrid cloud provides the flexibility of a house applications with the fault tolerance and scalability of cloud based services.
- PRIVATE CLOUD – Private cloud describes offerings that deploy cloud computing on private networks. It consist of applications or virtual machines in a company's own set of hosts. They provide benefits of utility co – putting

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shared hardware costs, the ability to recover from failure, and the ability to scale up or down depending upon demand.

CLOUD COMPUTING BENEFITS

Enterprises would need to align their applications. So as to exploit the architecture models that cloud computing offers. Some of the typical benefits are list below.

- Location independence, so long as there is access to the internet.
- Increased flexibility and market agility as the quick development model of cloud computing in creases the ability to re – provision rapidly as required.
- Allows the enterprise to focus on its core business.
- Increased competitive advantage.
- Increased security at a much lesser cost as compared to traditional stand alone applications due to centralization of data and increased security – focused resources.
- Reeducation in upfront capital expenditure on hardware and software development. Consumption is usually billed on a utility(like phone bills) or subscription (like magazines) model.
- Easy to maintain as they don't have to be installed on each user's computer.

CHARACTERISTICS OF CLOUD COMPUTING

There are some characteristics of cloud computing are mentioned as under.

- ON DEMAND SELF SERVICES :- Computer services such as e – mail, applications, network or server service can be provided without requiring human interaction with each service provider. Cloud services providers providing on demand self services include Amazon Web Services (AWS), Microsoft, Google, IBM and sales force.com.
- BROAD NETWORK ACCESS – Cloud capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms such as mobile phones, laptops and PDA's.
- RESOURCE POOLING- The provider's computing resources are pooled together to serve multiple consumers using multiple – tenant model with different physical and virtual resources dynamically assigned and reassigned according to consumer demand.
- RAPID ELASTICITY – Cloud services can be rapidly and elastically provisioned in some cases automatically to quickly scale out and rapidly released to quickly scale in. To the consumer the capabilities available for provisioning often appear to be unlimited can be purchased in any quantity at any time.
- MEASURED SERVICE – Cloud computing resources usage can be measured controlled, and reported providing transparency for both the provider and consumer of the utilized service. Cloud computing services use a metering capability which enables to control and optimize resources use. This implies that just like air time, electricity or municipality water, IT services are changed per usage metrics – pay per user.

CLOUD COMPUTING INITIATIVES FOR LIBRARIES:

Like all purpose cloud initiatives undertaken by giants, there are sizable number of initiatives relevant to libraries initiated by organizations and business houses which are in business of integrated library software, digital libraries, search engines etc.,

- OCLS's Web scale – OCLC (On Line Computer Library Centre) is a nonprofit, membership, computer library service and research organization dedicated to the public purposes of furthering access to the world's information and reducing the rate of rise of library costs years together OCLC has been functioning as a cloud computing vender because they provide cataloguing tools over the internet and allow member institutions to draw on their centralized data structure.11

  OCLC has implement the plan of library management system on the cloud which has delivery and circulation print and electronic acquisitions, cataloguing license management components. It World share Management Services (WMS) allow libraries to manage entire collection management in a cloud based application. The purpose is sharing resources to save money, promote community development and drive better services for library users.

  In other words it generate cost benefits for libraries and efficiencies not possible when utilizing discrete specialized systems. 12

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- EX – LIBRIS CLOUD: - Ex – Libris is a leading library software vender form USA. The company's next generation library system, Alma, was conceived as cloud based service to transform the traditional management of library resources. It besides ensuring savings in total cost, involved in the implementation of software and the use of centralized cloud service enable libraries to provide effective services for their users.13

  To provide world wide cloud based services it has opened data centers at various locations. The company promises to data security, updates, and standards in implementing cloud services to safeguards the interest of customers.

- DURASPACE'S DURA CLOUD:- Dura space provides open source repository solutions by undertaking turnkey projects for organizations and libraries to enable them to share scholarly literature using D space and Fedora Commons. Its new service Dura cloud provides digital preservation support service in the cloud which is cost effective and simple for libraries.

  The cloud solutions offered include online backup, preservation and achieves, media access, online shopping, and cloud broken.

CLOUD COMPUTING APPLICATIONS IN LIBRARIES

Libraries are in unique position to experiment with cloud computing given their service oriented mission and need to find appropriate solutions using limited resources. According to Fox 11 one of the key pressures that pushes libraries to cloud solutions and proves to be impediment to migration the availability of it support services. He also observes the goals and policies of organizations in making use of cloud computing services. These factors make SaaS and PaaS approaches appealing for libraries.

- AUTOMATION – Automation is an area, of the libraries to start in order day to day operations. Automation in libraries undertaken locally hosted servers using different types of commercial and open source integrated library management software vendors and third party services offering hosting of this service (SaaS approach) on the cloud to save libraries from investing on hardware.
- DIGITAL LIBRARY SERVICES:- Digital libraries or institutional repositories as part of modern libraries owing to changing format of information. The digital library services offered open source software. Such as D.Space, E prints, Fedora Commons etc.
- OFFICE APPLICATIONS :- Libraries are using various office applications such as word processing, spread sheets, power point presentation etc., using Microsoft office on the local computers. In cloud computing many applications are made freely available on the internet by companies like Google, Microsoft, etc., The information available on internet is also allows storing and sharing of resources with other colleagues who can remotely work on the documents of their geographical locations.
- STORAGE - Libraries require space to store the electronic files and document. The documents, could be office correspondence, full text documents, bibliographic records, tutorials etc., T he cloud computing has brought new services which offer space at no cost to store files and documentations. Libraries may take advantage of this store to undertake collaborative activities with other libraries. The digital preservation libraries are making use of services of CLOCKSS (http://www.clockss.org/clockss/home) and Portico (http://www.portocp.org/digital - preservation) to get permanaent access to the subscrined content irrespective of their publishers existence.
- SEARCH SERVICES :- Libraries have already migrated key services such as open URL providers and federated and pre – indexed search engines on the cloud either by using commercial or open sources solutions.

  E.g.: hosted Ex – libris service offers libraries to link – up to the subscribed Journal full – text article.
- WEBSITE HOSTING: Website hosting is one of the earliest adoptions of cloud computing as many organizations including libraries preferred to host their websites on third party service providers rather than hosting and maintaining their own servers.

ADVANATAGES AND DISADVANTAGES:

Like any other technology, cloud computing too has its advantages and disadvantages as compared to locally hosted services.

- ADVANTAGES: Some of the following advantages of cloud computing hosted services.
  1. Cost saving
  2. Increased storage
  3. Highly automated
  4. Flexibility and innovation

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5. Better mobility
6. Shared resources
7. Easy on installation and maintenance
8. User centric
9. Interoperability
10. Availability any time any where
11. Transparency
12. Create & Collaborate

- DISADVANTAGES: Following are some of the main disadvantages of cloud computing.
    1. Data security and privacy
    2. Network connectivity and brand band width
    3. Dependence on outside agencies
    4. Limited flexibility
    5. Cost Knowledge and integration.

CONCLUSIONS:

Cloud computing is a new baby in the computer systems technology emerged for developments in internet with associated technologies. The Cloud computing offers numerous benefits for different organizations, individuals and in Libraries also. Library professionals may find to manage the technologies, own to their skill levels. Lack of support form Information Technology department with in the organizations. This kind situation to under taking automation of Library activities and developing digital Library Services. Here cloud computing helps Libraries to undertake modern ICT activities. Library provide Cloud service, it has to think about its personal information, and that its users can be protected. In today's information society Libraries have the opportunity to improve their services with the help of cloud computing. It is one path for move into the future which brings excellence advantages for Libraries. Libraries have taken a big leap in adopting this technology especially in the west, but surely it will slowly spread to developing countries. It is evident from the literature that some service providers have already pitched into help libraries to automate and establish digital libraries on the cloud.

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EMERGING TECHNOLOGIES IN LIBRARIES: APPLICATION OF MOBILE TECHNOLOGY TO ENHANCE LIBRARY SERVICES

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ABSTRACT
Libraries are adapting new tools and techniques to store and also to retrieve information systematically. The increasing use of Information and Communication Technology (ICT) in academic libraries, changing nature of libraries from traditional to digital, availability of resources in various forms and formats have made a great impact on development of the academic libraries. Libraries are adapting new tools and techniques to store and also to retrieve information systematically. The use of mobile computing devices such as smart phones is rapidly increasing in the population. Libraries can serve better services to their users by embracing the growing capabilities of mobile technology. They can promote and expand their existing services by offering mobile access to their websites. This paper highlights about the emerging technologies in libraries and discusses the application of mobile technology in libraries to enhance the library services.

Keywords: *Mobile Technology, M-Libraries, Cloud Computing, RFID, Artificial Intelligence, Machine Learning*

INTRODUCTION

Academic Libraries are changing drastically in the modern world because of changing technology, e-publishing, and new ideas about library services and products. Libraries are adapting new tools and techniques to store and also to retrieve information systematically. The increasing use of Information and Communication Technology (ICT) in academic libraries, changing nature of libraries from traditional to digital, availability of resources in various forms and formats have made a great impact on development of the academic libraries. The use of mobile computing devices such as smart phones is rapidly increasing in the population.

Mobile Technology has transformed many aspects of our lives: how we work, how we communicate, how we study and how we play. At present, the total of around 904.51 million mobile users, as per latest data released by Telecom Regulatory Authority of India (TRAI), have excellent connectivity across regions. The dominant mobile network providers are Airtel, Tata DoCoMo, Vodafone, Idea Cellular, Reliance Communications and state run BSNL/MTNL.

Mobile technologies are rapidly growing and they have played an important role in the management of relations between people in social, economic and in everyday life (Goh, Kim, Lavanya, Kim, & Soh, 2006). Libraries are mastering the mobile Web to bring patrons a new set of services. They are offering information about library services and collections, providing access to library catalog search, portable exhibit information, subject guides, e-journals, and library hours, all formatted for the small screen (Kroski, 2007).

The Indian educational system is developing. It is changing from d-learning (distance learning) to e-learning (Electronic Learning) and now from e-learning to m-learning (Mobile Learning) and it will be the next great task. M-learning will bring about a paradigm shift from the Old methods of education delivery, and integrate ICT as an essential component in every days learning.

Academic library professionals need to acquire such knowledge and skills as the library and information profession is a highly IT influenced profession.

EMERGING TECHNOLOGIES IN ACADEMIC LIBRARY

- Cloud Computing
- RFID Technology
- Mobile Technology
- Artificial Intelligence & Machine Learning

Cloud Computing

"Cloud computing is Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand through the Internet"

The combination of servers, networks, connection, applications and resources is defined as 'cloud'. Cloud computing is a comprehensive solution that delivers IT as a service. It is an Internet-based computing solution where shared resources are

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provided like electricity distributed on the electrical grid. Computers in the cloud are configured to work together and the various applications use the collective computing power as if they are running on a single system. With Cloud Computing users can access database resources via the Internet from anywhere, for as long as they need, without worrying about any maintenance or management of actual resources.

RFID (Radio Frequency Identification) Technology

Radio Frequency Identification (RFID) technology changed the concept of security around the world. RFID is a generic term that is used to describe a system that transmits the identity of an object or person wirelessly, using radio waves. RFID allows an item, for example a library book, to be tracked and communicated with by radio waves.

The antenna enables the chip to transmit the identification information to a reader. The reader converts the radio waves reflected back from the RFID tag into digital information that can then be passed on to computers that can make use of it.

Artificial Intelligence (Ai) and Machine Learning (ML)

Artificial intelligence (AI) and machine learning (ML) have brought about a significant change in the world of modern libraries, turning them from passive repositories of knowledge to intelligent centers for information gathering and sharing. By streamlining procedures, improving search capabilities, tailoring user experiences, and providing insightful data on user preferences, the integration of these technologies has had a significant influence. This section examines the ways in which artificial intelligence (AI) and machine learning (ML) have become disruptive technologies, transforming library systems through information retrieval, recommendation systems, predictive analytics, and cataloging.

Automating Processes: By automating repetitive chores, AI and ML are simplifying library operations and freeing up human resources to work on more complex projects. Artificial intelligence (AI) systems can now effectively handle tasks like cataloging, metadata tagging, and sorting, decreasing the need for human labor and improving overall operational efficiency. Libraries can strategically manage resources thanks to automation, which maximizes staff productivity and time.

Enhancing Search Capabilities: It can be difficult to find pertinent search results in traditional library catalogs. By comprehending context, semantics, and user purpose, AI-powered search engines enhanced with machine learning algorithms can improve search capabilities. The utilization of Natural Language Processing (NLP) approaches facilitates more accurate and intuitive search functions, resulting in expedited information retrieval and access.

Personalizing User Experiences: By customizing suggestions and services based on previous behavior and preferences, AI and ML allow libraries to provide each user with a personalized experience. By recommending pertinent books, articles, or other materials based on user interactions and borrowing history analysis, user pleasure and engagement are increased. Customization creates a feeling of community and motivates patronage of library resources over time.

Recommendation Systems: Personalized suggestions are generated by AI-driven recommendation systems that examine user behavior, preferences, and patterns. These systems make recommendations for pertinent books, articles, or other materials based on the user's past usage or expressed interest in. This greatly improves discoverability and motivates people to delve deeper into a wider variety of content.

Predictive Analytics: Predictive analytics is made easier in libraries by AI and ML, which helps with resource allocation and decision-making. Libraries can foresee trends, enhance collection development, and distribute resources efficiently by examining historical borrowing patterns, user demographics, and circulation data. By using data-driven strategies, library services can be adjusted to meet changing customer needs.

Information Retrieval: Information retrieval in libraries has been completely transformed by sophisticated AI algorithms, especially deep learning models. Libraries today serve as intelligent ecosystems that adjust to the needs and interests of their patrons, going beyond simple physical repositories. Applications of AI and ML are not only increasing search efficiency and automating procedures; they are also improving user experiences and offering priceless insights that enable libraries to provide better services to their communities.

Mobile Technology

Wireless technology and mobile phones are becoming an integral part of everyday life and are changing the ways we connect and interact with the world around us. Mobile technology has brought outstanding changes in various fields and particularly in education. People are using devices like laptops, mobile phones, tablets, e-readers, iPods, PDAs, handheld gaming consoles etc., They are now also being used to access e-mail, search the Web, Video chat, interact and discus on social media, and play games etc.,

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With a growing number of people accessing the Internet from their pocket PCs and mobile phones, libraries are investigating ways to deliver their services to mobile phones and other small-screen devices so that their patrons can access them any time anywhere. This can be as simples as sending text message alerts about reservation becoming available or overdue books or as complex as digital reading room, which allows readers to access full eBooks and journal article through their library's subscriptions on any mobile device. There services have collectively become known as 'M-Libraries', a shortening of the phrase 'Mobile Libraries'.

Fig 1: Difference in view of Standard & Mobile Optimized Websites.

APPLICATION OF MOBILE TECHNOLOGY IN LIBRARIES

A mobile application is software written for mobile devices that performs a specific task, such as a game, calendar, music player, etc. In the mobile realm, we frequently come across terms like Native app or Web app. Libraries can better serve their users by embracing the growing capabilities of mobile technology. They can promote and expand their existing services by offering mobile access to their websites and online public access catalogs; by supplying on-the-go mobile reference services; and by providing mobile access to e-books, journals, video, audio books, and multimedia content.

Mobile Web in Libraries

Mobile libraries are libraries that deliver information and learning materials on mobile devices such as smart phones, personal digital assistants (PDAs), Tablet phones and iPods to allow access by any one from anywhere and at any time.This will result that the library services and information in the library are able to be accessed anywhere and any time using these mobile devices.

The following services may be offered in mobile phones.

- SMS alert services

  Following are possible ways to send SMS from libraries

  - ✓ Few Library automation software's provide option to send SMS alerts for reserved items, due items to users. For example, Libsys 0.7 & E-granthalaya
  - ✓ Plug-ins integrated with library email system to enable email to SMS messaging.
  - ✓ To send SMS to collect the requested books
  - ✓ Reminding the user if, book is due in his/her account; informing user about the exact fine.
  - ✓ Acknowledging the user about renewal of a book.
  - ✓ Users may request the opening hours/ Holidays of the library via SMS.
  - ✓ News and event reminder service via SMS.

- Electronic Resources with Mobile Interfaces

  Mobile interfaces are webpages that are graphically adjusted for smaller screens. The Mobile Access webpage has a list of mobile interfaces and apps in all subject areas. Mobile apps are software that is downloaded to your smartphone or tablet.

  Mobile interfaces offer a variety of databases and digital resources such as e-Books, e-Journals, e-databases, dissertations, images and article databases. These collections can either be downloaded from the library websites on user's own mobile devices or libraries lend mobile devices with the collections already on them. A large collection of audio books both free-and subscription-based services are available for download and also transferable to mobile devices.

  Most of the e-book publishers provide 24x7 accesses to the library subscriptions from any internet terminal within the campus, as well as on mobile devices, such as iPods, Android devices, and Kindle.

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Example:

- ACM Digital Library has a mobile app for both iOS and Android devices.

  www.dl.acm.org
- IEEE Xplore Digital Library

  www.m.ieee.org
- WorldCat connects to the collections and services of more than 10,000 libraries worldwide.

  www.worldcat.org/m/

  Librarians are required to become familiar with mobile technologies, and work with vendors and IT experts to ensure that e-collections of their libraries are mobile-friendly.
- Library guide

  Libraries can give users the best of library guide information such as library use guide, question answering service, and library statistics delivering rich content in a way that works best for users. If users have questions and want to contact the librarian for help, they can get a fast response from the library via the mobile device and find the appropriate information needed.
- Suggest a purchase

  Librarian can receive the suggestions from the users sent via mobile phones. In such cases users need not to visit the libraries and write the requirements in a register.
- Mobile AVOD system

  The mobile Audio and Video on Demand System (MAVD) enables users to Listen/Watch Audio and Video contents of the library's AVOD system on the mobile devices through Bluetooth, Wi-Fi or 3G. The MAVOD system has licensed videos, English Language Learning Programs, and lectures/speeches delivered.
- Location of the library

  Users might be provided with virtual tours of the library sections and their services.

  For instance, Library of Congress provides an application prepared for the iPhone users which gives a virtual tour of Library of Congress that mirrors the main reading room, the great hall, the bible collection etc.
- Library Virtual/Audio Tour

  Library users, who don't have time or inclination to attend an on-site workshop, can get access to library tours on their mobile devices. Audio/ virtual library tours can be produced fairly quickly, inexpensively, and could reduce the amount of staff time spent helping new users to orient themselves in the library and explaining the facilities available. It can easily be provided both as downloads from the library website and on mobile devices.

  Libraries even can provide audio tour of a library. For example, University of Limerick library, Ireland provides audio guidelines to the library users (University of Limerick Library, 2012).
- New Title Preview

  Mobile gadgets can be used to disseminate the information about newly acquired documents which are of irrespective of forms.
- QR Codes on Mobiles

  A QR code is a matrix barcode readable by smart phones and mobile phones with cameras. They are sometimes referred to as 2d codes, 2d barcodes, or mobile codes. On most phones purchased in the United States, one must download a free app (application) in order to read the QR code, although some phones have one preinstalled. QR codes can hold much more information than a regular barcode. The information encoded in a QR code can be a URL, a phone number, an SMS message, a V-card, or any text.
- Wi-Fi - Internet Access

  Mobile phones are available with 3G facility.

  Libraries can offer wi-fi facility to access electronic information sources.

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- Catalogue search

  Library catalogue: Libraries can provide their catalogue on the mobile devices. University of Cambridge has made a provision to search the library catalogue from the mobile device. The service can be viewed by accessing the URL - http://www.lib.cam.ac.uk/mob/#menu

- Journal finder: Library Journal Finder provides access to full text journal, magazine, and newspaper content as well as links to titles held in print. For instance, American University library has providing option to search journals through mobile phones. The URL for this service is http://www.library.american.edu/mobile/get_article.html
- Reference service: Library users can ask librarians anything through the live chat and texting with mobiles. The reference services can be provided with the help of sending and receiving SMS. Immediate feedback is also possible from the user's side.
- E-readers. Despite being available for decades, the general public has only become aware of e-readers in the last 5 years, primarily due to the popularity of Amazon's Kindle and Barnes & Noble's Nook.
- Electronic textbooks. One of the next great digital frontiers being tackled is that of academic texts. E-readers and tablets have new features that allow students to highlight and add annotations to the text, just as they would with paper texts. They give students the capability to link to additional information.

Some of the Publishers Offering Database through Mobile:

Publisher/Database	Mobil App.
1. American Chemical Society	iOS and Android
2. American Institute of Physics	iOS
3. All EBSCO host databases	iOS and Android
4. Elsevier	iPhone and Android
5. Gale Cengage	iPhone and Android
6. PubMed medical database	iPhone apps and Android app.

ADVANTAGES OF MOBILE APPLICATIONS FOR LIBRARY SERVICES

- It improves access to library collection and services for audiences, wherever they are, whether onsite or anywhere else in the world.
- Helps in equipping staff to champion and drive the development of mobile services to improve access and productivity.
- Modernizes the library brand to reflect relevance, accessibility and innovation.
- Creates opportunities for learning.

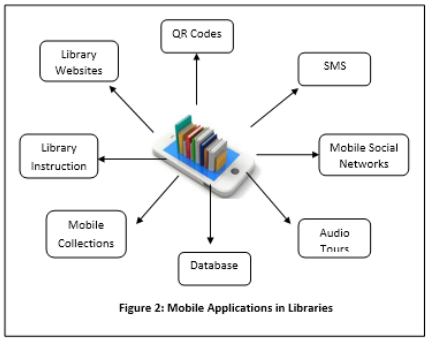

Figure 2: Mobile Applications in Libraries

Mobile Websites

In addition to mobile applications, some companies and organizations develop mobile versions of their web site that are better optimized for viewing on mobile devices.

Encyclopedia Britannica Mobile: http://i.eb.com

MedlinePlus Mobile : http://m.medlineplus.gov

WorldCat Mobile : http://www.worldcat.org/m

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Creating Mobile Web sites, OPACs and applications

Name of the Applications	Purpose	Mobile Compatibility	Provider/ URL
Android Developers	Resources for creating Android applications. Includes developer guide, tutorials and videos.	Android Phones	http://developer.android.com
AirPac (Innovative Interfaces)	Library catalog. Includes features such cover images, integrated library locations with Google Maps software, request and renew items, and more.	All web enabled phones	http://www.iii.com/products/airpac.shtml
Boopsie	Specializing in public and developer Matthew Leak outlines one way to create an iPhone-friendly version of a web site.	All web enabled phones	http://www.boopsie2.com
MobilePress	Mobile press is a free plug-in for word press blogs which will automatically transform you blog into a mobile version which such a device is detected.	All web enabled phones	http://wordpress.org/extend/plugins/mobilepress/
Library Anywhere	Creating and sold through Library Thing, Library Anywhere is a mobile catalog for any library. Includes mobile web an apps for iPhone, Blackberry and Android.	All web enabled phones	http://www.librarything.com/forlibraries
MobileTuts+	Tutorials for all mobile developers, regardless of platform. Topics include techniques for building mobile apps and mobile web sites	All web enabled phones	http://mobil.tutsplus.com
MoFuse (Mobile Fusion)	Build a mobile version of an existing web site or blog with the MoFuse content management platform	All web enabled phones	http://mofuse.com
Zinadoo	Users can add ready-made widgets such as guestbook's, email, call me and feedback forms as well as RSS feeds.	All web enabled phones	http://zinadoo.com

M-Library services using Mobile Applications

Name of the Services	Purpose	Mobile Compatibility	Provider/ URL
Mobile Online Public Access Catalogues (MOPACs)	Libraries are providing access to their OPACs via mobile-optimized websites. The New York public library mobile beta site supports a mobile. MOPAC and allows users to browse library locations and hours.	All web enabled phones	http://m.nypl.org
Mobile Applications	Some libraries have developed mobile applications for smart phones. The District of Columbia Public Library.	All web enabled phones	http://dclibrarylabs.org/projects/iphone/
Mobile library instruction	Offering library instructional materials and resources via mobile platform. Ex: East Carolina University's "Research First Aid" is a series of podcasts for library researchers on the go.	All web enabled phones	http://www.ecu.edu/cs-dhs/lauuslibrry/researchfirstaid.cfm
Mobile Collections	Third party content providers are partnering with libraries to deliver audio books, e-books, audio language courses, streaming music, films, images and other multimedia that can be used on mobile devices. *Example:* overdrive service support for Blackberry smart phones.	All web enabled phones	http://www.overdrive.com
Duke Mobile	Duke University has created a free iPhone application called Duke Mobile.	All web enabled phones	http://itunes.apple.com/app/dukemobile/id306796270?mt=8
SMS Reference	Some libraries are offering "text-a-librarian" services ideal for simple questions that can be answered with brief response.	All web enabled phones	http://www.library.yale.edu/science/text,sg/html

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Library Short Message Service (LSMS) Notifications	Many libraries use SMS for a variety of purposes, including notification for items available for pickup, due date reminders, information on availability of library materials, provision of call numbers and locations and others.	All web enabled phones	http://cpl.org/?q=node/12258

CONCLUSION

Mobile Technology has transformed many aspects of our lives: how we work, how we communicate, how we study and how we play. Mobile Web library services transcend time restrictions. It facilitates patrons transcend spatial limitations, allowing them to enjoy the services provided by the library without having to go to the library and 24 hours a day using with their mobile phones.

Academic libraries need to create mobile applications that serve as customizable interface and ensure full and flawless access to all library resources and services. Librarians should seek faculty on their campuses who are developing or using innovative tools like those described here and begin experimenting with them in partnership with faculty and students. Mobile devices can offer more opportunities for students to be actively engaged in their learning and to fully participate in the social nature of learning. These developments show how libraries can adapt to a world that is becoming more and more digital, from increasing user interaction to guaranteeing the longevity of digital resources. Academic library professionals need to acquire such knowledge and skills as the library and information profession is a highly IT influenced profession.

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AI, ML AND AUTOMATION IN LIBRARY SERVICES

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ABSTRACT

Artificial Intelligence (AI) is transforming academic libraries into dynamic centers of personalized learning, work more efficiently, and ethical engagement. This chapter looks at how AI technologies like machine learning, natural language processing, predictive analytics, and virtual assistants are changing the way libraries work and pedagogical roles. The study looks at how librarians' roles are changing as they work to improve AI literacy and make sure everyone can use it. It does this using frameworks like Technological Pedagogical Content Knowledge (TPACK) and Critical Information Literacy.

The study looks at how to strategically integrate AI into library services like cataloging, information retrieval, research support, and helping users by using bibliometric data, practitioner experiences, and policy developments. The Indian academic setting is given special attention because of the effects of limited infrastructure, language diversity, and ethical issues on implementation.The chapter makes the case for a balanced, human-centered approach to adopt AI that safeguards transparency, openness, and critical thinking. Ultimately, it positions academic libraries as places that can change the way people think and work by using technology to support professional judgment, scholarly communication, and the growth of sustainable knowledge ecosystems.

Keywords: *Academic Libraries, Artificial Intelligence, Machine Learning, AI Literacy, Research Communication.*

Introduction

Academic libraries have long served as vital institutions supporting learning, research, and knowledge dissemination. Libraries used to depend on people to help them organize their collections, guide users, and manage their resources. Now, they are going through a digital evolution. Artificial intelligence (AI) has brought us tools like machine learning (ML), natural language processing (NLP), and virtual assistants. These tools have changed the way people use computers and how businesses work. This chapter looks at how AI is changing the library ecosystem by balancing new ideas with moral responsibility and teaching goals.

Literature Review

Over the decades, the role of AI in academic libraries has undergone a remarkable transformation. In the early stages, from the 1950s through the 1980s, efforts centered on automating cataloging and indexing processes, with innovations like MARC standards and Online Public Access Catalogs (OPACs) laying the groundwork for future advancements (Chhetri, 2023). By the 1990s and 2000s, libraries began adopting AI-powered tools such as expert systems and NLP, which significantly improved reference services and metadata organization. More recently, the emergence of ML, chatbots, and predictive analytics has ushered in a new era of "smart libraries," where services are increasingly tailored to individual needs, driven by data, and designed for greater efficiency and personalization (Priyadarshini & Dubey, 2024).

A range of theoretical frameworks has shaped the evolving role of AI in academic libraries. One such model is the TPACK framework, originally developed for educators, which has been thoughtfully adapted to evaluate AI literacy among library professionals. It highlights the need to blend technological know-how with pedagogical insight and subject expertise (UNESCO MGIEP, 2024). Alongside this, Critical Information Literacy offers a more reflective lens, challenging the biases embedded in AI-generated content and calling for greater transparency and ethical scrutiny. A key conversation also revolves around Human-AI collaboration, which emphasizes that AI should enhance, not replace, human judgment and expertise in library settings (Chhetri, 2023).

AI is reshaping how academic libraries operate on multiple fronts. In cataloging, it streamlines classification and ensures metadata remains consistent and accurate. NLP tools are transforming how users search for information, offering more intuitive, context-aware results. Chatbots now provide round-the-clock, personalized assistance, making library services more accessible than ever. When it comes to building collections, predictive analytics help librarians make smarter acquisition decisions. And in the realm of digital preservation, technologies like Optical Character Recognition (OCR) and anomaly detection are safeguarding valuable resources. Together, these innovations are opening up exciting possibilities: enhancing accessibility, supporting diverse languages, improving operational efficiency, and enabling more strategic, data-driven planning (Priyadarshini & Dubey, 2024).

Research Methodology

This study adopts a qualitative meta-synthesis approach to explore how AI has been implemented in academic libraries. It brings together insights from a wide spectrum of sources, ranging from peer-reviewed articles and institutional documents

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to real-world case studies, offering a nuanced understanding across educational, ethical, and technological domains. The analysis spans the years 2010 to 2025, capturing both the early groundwork and the latest innovations that have shaped the field.

Search Strategy and Selection

The literature search was shaped by a carefully crafted keyword strategy, using terms like "AI in Libraries," "AI Literacy," "Smart Libraries," "Pedagogical AI Tools," and "Inclusive Access Technologies." The selection process prioritized studies that aligned with the educational goals of academic libraries, addressed ethical dimensions of AI use, and examined the technological frameworks that enable effective AI integration.

Data Sources and Collection

To build a robust foundation for this study, literature was sourced from leading academic databases including Scopus, Web of Science, and SpringerLink. Additional insights were drawn from UNESCO MGIEP reports and practitioner-focused platforms such as ResearchGate. The selection process emphasized works that explored key themes, AI literacy, smart library infrastructures, pedagogical applications of AI, and technologies that promote inclusive access.

Limitations

This study recognizes several limitations that shape its scope and findings. One key concern is the uneven regional representation across the literature, which may influence the generalizability of insights. Access to proprietary AI technologies also remains restricted, posing challenges for comprehensive analysis. Additionally, the fast-paced evolution of AI demands continual updates to the research corpus to ensure relevance and accuracy over time.

Evolution of AI in Academic Libraries

The journey of AI in academic libraries spans decades, evolving from mechanical systems to intelligent, user-focused services. In the early years, from the 1950s to the 1980s, libraries began automating core functions using tools like MARC standards and OPACs, which helped standardize bibliographic records and improve access (Chhetri, 2023). By the 1990s, technologies such as NLP and expert systems began to surface, offering basic semantic search capabilities and decision support. Fast forward to today, and libraries are transforming into smart ecosystems, driven by ML, chatbots, and predictive analytics, that prioritize personalization, proactive engagement, and data-informed strategies (Priyadarshini & Dubey, 2024).

Practical Applications of AI in Library Services

AI is transforming academic library services by introducing intelligent technologies that boost efficiency, broaden access, and deepen user engagement. Some of the most impactful applications include:

- **Search Enhancement:** NLP and ML help interpret user intent, making searches across catalogs and databases more intuitive and context-sensitive.
- **Streamlined Cataloging:** AI automates metadata tagging, classification, and indexing—reducing manual effort and ensuring greater consistency in bibliographic records.
- **Personalized Recommendations:** Recommender systems analyze borrowing patterns and search behavior to offer personalized content, encouraging more meaningful interactions with library collections.
- **Chatbots & Virtual Assistants:** Chatbots and virtual assistants provide 24/7 help with queries, navigation, and policy information, making library services more accessible and user-friendly.
- **Predictive Analytics:** Predictive analytics allow libraries to anticipate trends in resource usage and acquisition, supporting smarter, data-driven decisions.
- **Inclusive Design:** Tools like text-to-speech, real-time translation, and adaptive interfaces ensure that services are accessible to users with disabilities and those from multilingual backgrounds—advancing equity and universal access.

AI in the Indian Academic Context

In the Indian context, the integration of AI into academic libraries is unfolding gradually, marked by cautious optimism. Emerging technologies like smart shelving, OCR, and AI-assisted cataloging are beginning to gain momentum. Yet, persistent challenges, such as limited funding, infrastructural gaps, and misaligned policy frameworks, continue to shape the pace of adoption. Insights from a recent survey of Indian librarians reflect a nuanced landscape: while many are hopeful about AI's potential to improve service delivery, concerns linger around job security, ethical oversight, and ensuring equitable access for all users.

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Opportunities Presented by AI in Academic Libraries

Artificial Intelligence is reshaping the landscape of academic libraries, driving improvements in efficiency, user engagement, and inclusive access. A major shift is evident in the automation of core workflows, cataloging, indexing, and inventory management. With AI algorithms at the helm, libraries can now generate metadata, classify resources, and monitor collections with greater accuracy and reduced manual effort.

Strategic decision-making is increasingly guided by AI-powered analytics. By analyzing user interactions, borrowing habits, and search behaviors, libraries can refine their collection strategies, make informed acquisitions, and allocate resources more effectively. Predictive tools further enable libraries to anticipate future needs, ensuring they stay aligned with evolving academic priorities. Research capabilities are being elevated through advanced technologies like semantic search and data mining. These tools empower users to access contextually rich information, discover interdisciplinary links, and navigate expansive digital archives with precision. AI-driven discovery platforms are fostering deeper, more meaningful engagement with scholarly materials.

Inclusivity remains a cornerstone of AI's impact. Assistive technologies, such as screen readers, text-to-speech systems, and real-time translation, support users across diverse linguistic and ability spectrums. Adaptive interfaces, designed with universal access in mind, help ensure that all users can interact with library resources equitably. Personalization is another transformative dimension. AI-enabled recommendation engines and adaptive learning platforms tailor content to individual preferences, academic objectives, and learning styles. This level of customization not only enhances user satisfaction but also nurtures self-directed learning pathways.

Competency	Description	Key Tools
Basic AI Knowledge	Understanding core AI mechanisms and terminology	Google Cloud Vision OCR
Bias Evaluation	Identifying algorithmic distortions in search and curation	Unpaywall
Regulatory Awareness	Navigating legal frameworks governing AI	DPDP Bill Toolkit
Pedagogical Adaptation	Integrating AI into curriculum-aligned learning activities	Overleaf, LibChat
Collaboration Networks	Participating in global dialogues on AI and digital access	Bibliometrix, VOSviewer

AI is also playing a transformative role in advancing professional development within academic libraries. Through intelligent training systems and collaborative digital platforms, library staff are empowered to expand their skill sets, adopt emerging technologies, and engage in interdisciplinary initiatives. This not only cultivates a culture of lifelong learning but also redefines libraries as vibrant centers of innovation, knowledge exchange, and technological leadership.

Importance and Impact of AI

AI is ushering in a new era for academic libraries, transforming not just how they operate but how they connect with users. Key advancements include:

- **Personalized Experiences:** Tailored services and intelligent recommendations are enriching user engagement and satisfaction.
- **Operational Efficiency:** Routine tasks such as cataloging and data management are being streamlined through automation, freeing up staff for more strategic roles.
- **Insightful Decision-Making:** Data-driven analysis supports smarter collection development and resource allocation.
- **Content Discovery & Access:** AI tools enhance the creation and curation of materials, improving visibility and accessibility across platforms.
- **Anticipating Needs:** Predictive analytics help libraries stay ahead of user expectations and academic trends.
- **Research Intelligence:** Text and data mining uncover emerging scholarly patterns, enabling evidence-based planning and innovation.
- **Inclusive Access:** Assistive technologies empower users with disabilities, ensuring equitable participation in academic life.

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- **Preservation for the Future:** Automated digital archiving safeguards resources for long-term accessibility and scholarly continuity.
- **Collaborative Ecosystems:** AI-powered chatbots and recommendation systems foster knowledge exchange and community building.
- **Strategic Edge:** These innovations offer libraries a competitive advantage, enhancing cost-effectiveness, adaptability, and their broader social impact.

The integration of AI technologies into academic libraries is unlocking a wide array of benefits, from expanding access to resources and automating routine tasks to enriching user experiences. Key applications include:

- **Chatbots:** Available around the clock, AI-driven chatbots assist users in locating resources, accessing information, and managing reservations, significantly enhancing service accessibility.
- **Recommender Systems:** These systems personalize the discovery process by suggesting resources aligned with users' interests and past interactions, fostering deeper engagement.
- **Text Mining:** By analyzing vast textual datasets, journals, articles, e-books, AI helps uncover research trends and thematic patterns, supporting scholarly inquiry.
- **Predictive Analytics:** Libraries can anticipate user needs and preferences, enabling more responsive and tailored services.
- **Digital Preservation:** AI safeguards digital collections by detecting risks like data degradation or corruption, ensuring long-term accessibility.
- **Image Recognition:** This technology streamlines the classification and retrieval of visual materials, making image-based resources more discoverable.
- **NLP:** NLP enhances communication and search functionality by interpreting and responding to human language with greater nuance.
- **Citation Analysis:** AI tools assist in identifying influential research and mapping scholarly impact, aiding both librarians and researchers.
- **Digital Assistants:** These virtual aides offer personalized support, guiding users through research queries and resource navigation.
- **Accessible Materials:** AI-powered tools like text-to-speech and captioning promote inclusive access for users with disabilities.
- **Inventory Management:** Intelligent systems help libraries monitor usage patterns, optimize collections, and reduce resource redundancy.
- **Fraud Detection:** AI strengthens digital integrity by identifying suspicious activities such as phishing or misinformation.
- **Data Visualization:** Advanced visualization tools reveal patterns and insights in complex datasets, supporting evidence-based decisions.
- **Learning Analytics:** These tools analyze student engagement and performance, enabling personalized feedback and improved learning outcomes.

Collectively, these innovations illustrate how AI is transforming academic libraries, not just by refining technical processes, but by deepening scholarly engagement and advancing inclusive access to knowledge. As AI continues to evolve, librarians must remain agile, reflective, and ethically anchored in their approach to technology adoption.

Implications for Academic Libraries

Aspect	Explanation
Strengths	Efficiency, personalization, enhanced discovery, multilingual access
Weaknesses	Bias in algorithms, data privacy risks, ethical concerns
Possibilities	Predictive planning, inclusive service design, AI-assisted pedagogy

Role of AI in Research Communication

Artificial Intelligence is reshaping scholarly communication in profound ways, transforming how research is created, shared, and understood. One standout contribution is literature mapping, where AI tools scan massive databases to visualize citation

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networks and spotlight emerging research areas. These dynamic maps help scholars trace intellectual movements, uncover collaborative clusters, and identify gaps ripe for exploration (Zhao, 2024).

Text summarization technologies are streamlining academic workflows by condensing complex studies into clear, digestible summaries. By surfacing key insights from dense materials, these tools enable researchers to engage with literature more efficiently, especially valuable in interdisciplinary or time-sensitive research contexts (Tetzner, 2024).

AI-powered question-answering systems add precision to information retrieval. By extracting evidence-based responses tailored to specific queries, these systems support rigorous analysis while easing cognitive demands (Tetzner, 2025).

Language translation tools are breaking down long-standing barriers to global collaboration. Advanced AI translators make scholarly work accessible across languages, fostering inclusivity and enabling researchers from diverse backgrounds to contribute meaningfully to global conversations in science, policy, and innovation (Amano, González-Varo, & Sutherland, 2016; Bowker & Steigerwald, 2022; Gordon, 2024; Lion, Lin, & Kim, 2024).

Plagiarism detection systems, powered by AI, help uphold the integrity of academic publishing. By scanning submissions against vast content repositories, these tools reinforce ethical standards and protect scholarly credibility (Potteiger, 2024).

Taken together, these innovations are not just accelerating the flow of knowledge, they're democratizing it. AI is acting as a catalyst for equity, connection, and collaboration across the scholarly landscape.

Conclusion

Artificial Intelligence is reshaping the identity of academic libraries, driving improvements in operational efficiency, user engagement, and inclusive access to information. This chapter has traced how AI's integration into library systems and pedagogical frameworks signals a meaningful evolution in the scope and purpose of academic services. By automating routine tasks such as cataloging and metadata generation, AI allows library professionals to focus on higher-order responsibilities, fostering collaboration, critical thinking, and innovation. It also enables personalized services, intuitive resource discovery, and multilingual support, all of which are essential for advancing equitable access to knowledge.

Yet, these technological strides come with significant ethical and infrastructural challenges. Concerns around algorithmic bias, data privacy, and over-reliance on technology call for thoughtful design, regulatory coherence, and ongoing staff development. AI literacy must extend beyond technical know-how to encompass ethical awareness and a commitment to human-centered service. Pedagogical frameworks like TPACK and Critical Information Literacy offer valuable guidance, helping librarians balance innovation with reflective practice.

In the Indian context, AI adoption in academic libraries is steadily progressing, though it remains shaped by constraints in funding, infrastructure, and governance. A phased, context-sensitive approach is essential. The emphasis on universal design and inclusive access is especially critical, given India's linguistic diversity and uneven resource distribution across educational institutions.

AI is also revolutionizing scholarly communication, enhancing literature mapping, semantic search, multilingual translation, and ethical publishing practices. These tools not only improve access but also democratize research visibility, encouraging interdisciplinary collaboration and accelerating evidence-informed learning.

Ultimately, the future of academic libraries lies not in full automation, but in their evolution as adaptive, intelligent spaces that blend technological precision with human insight. Strategic AI adoption must be guided by values of equity, transparency, and adaptability. By embedding AI competencies into professional development and fostering interdisciplinary collaboration, libraries can position themselves as key drivers of digital education, sustainable knowledge ecosystems, and lifelong learning.

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ELECTRONIC RESOURCE MANAGEMENT: E-RESOURCE ACQUISITION AND LICENSING IN ACADEMIC LIBRARIES

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ABSTRACT

Emerged ICT has changed the traditional concept of the library. Libraries are fast moving in this Internet era from the manual mode of action to digital access. Technological integration has redefined library services. By collecting diverse resources, the digital library has brought a new dimension to how library services operate in collecting varied resources. As libraries increase their dependence on these resources, their effective management becomes essential. Electronic resource management (ERM) subsequently became a core function that many academics effective implementation seems to be challenging for libraries around the world. It is helpful in the teaching-learning process and promotes research and development. This paper would help the librarians to understand the challenges in procuring and managing electronic resources and to take appropriate measures to avoid the issues related. The aim of the paper is to provide an overview of procurement policies, current trends, issues and challenges faced by the library professionals to provide an effective electronic resource collection to its users in a better way.

Key Words: *Academic libraries, Electronic resources, Electronic resource Management, E-Resources Acquisition Methods, E-Resource Licensing*

Introduction

The traditional concept of the library has changed with emergence of ICT. The concepts of electronic library, digital library, and virtual library came into the present situation. ERM stands for Electronic Resource Management, referring to the processes, practices, and software systems libraries use to handle digital materials like e-journals, databases, and e-books throughout their lifecycle, from selection, acquisition, licensing, and access to ongoing maintenance, usage tracking, evaluation, and preservation. ERM systems help manage complex subscription details, license agreements, access rights, and usage statistics. Smith (2006) viewed that electronic resource management (ERM) is an area of technical services responsible for the evaluation, selection, pricing, securing, maintenance and provision of electronic resources such as e-journals, e-books and databases. As e-collections explode in size and use, Electronic Resource Management (ERM) became a specialized, distinct job within library acquisitions, requiring unique skills for librarians to manage digital assets like e-journals and databases. Anderson et al. (2004) Described an ERMS as a system to manage information and workflows for various stages of electronic resources, including selection, evaluation, acquisition, maintenance, and access, in accordance with their terms. IFLA While defining e-resources, points out the need for management related to aspects like access control and licensing.

Electronic Resource Management (ERM) within the context of library science refers to the systematic approach and set of practices employed by libraries to acquire, organize, maintain, and provide access to electronic resources. These electronic resources encompass various digital materials, including e-books, e-journals, databases, streaming media, and other digital content. ERM involves various tasks such as acquisition, cataloging, licensing, authentication, access management, usage monitoring, and preservation of electronic resources. The primary goal of ERM is to ensure that library patrons have seamless access to a diverse array of electronic resources while efficiently managing the complexities associated with digital materials, including licensing agreements, copyright compliance, budget constraints, and technological requirements. By implementing effective ERM strategies, libraries can optimize the use of electronic resources, enhance user experience, and fulfill their mission of providing equitable access to information in the digital age.

E-Resources Acquisition Methods

The process of identifying, selecting, and obtaining electronic materials like databases, e-journals, and e-books for library users called Acquisition. Benny, (2015) in his study said that, E-resources can be acquired either through purchase, subscription or consortia, he further stated that, subscription to e-resource is the commonly used method by a large number of libraries for acquiring e-resources. There are four methods of acquiring electronic resources in academic libraries according to Creibaum and Holloway (2017) these are: Subscription, Purchase, Consortium and Open Access. Library acquisitions is the process of selecting and acquiring selected materials for library and information centers in all formats including digital items and maintaining the necessary records related to acquisitions. First, the selections of materials are done according to the collection development policy of the library. User recommendations, subject relevance, network capability, user-friendliness, content relevance, and retrieval efficiency.

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Subscription Model: Most common method of acquisition is subscriptions method. Libraries pay a recurring fee (annual/multi-year) for access. Access ends when the subscription expires just like subscribing to Netflix for content. Examples: Publisher packages (Taylor & Francis, Emerald), Aggregators (JSTOR, Project MUSE, EBSCO collections).

Advantages: Access to updated content. Predictable costs.

Limitations: No ownership, Continuous budget commitment.

Perpetual Access: Subscription by purchase method is called perpetual access method. A one-time purchase for ongoing access, often with optional annual maintenance/support fees. Patron-Driven Acquisition (PDA). Library pays once and retains permanent access. Often applies to e-books and back files of journals.

Advantages: Long-term value. No recurring payments.

Limitations: High upfront cost. Limited updates.

Consortia-Based Acquisition: Multiple libraries form a consortium to negotiate pricing. Shared access to e-resources.

Advantages: Cost-effective. Broader resource access

Limitations: Limited choice flexibility. Dependent on consortium policies.

Demand-Driven Acquisition (DDA) / Patron-Driven Acquisition (PDA): Resources are purchased only when users access or request them.Widely used for e-books.

Advantages: User-centric. Reduces unused purchases

Limitations: Budget unpredictability. May favor popular over scholarly works

Open Access (OA) Resources: Allow free access to scholarly content. Includes OA journals, repositories, and databases. unrestricted access to scholarly works, often under Creative Commons (CC) licenses for non-commercial share, adapt, use commercially, build upon, Share, adapt, build upon (non-commercial only) or open-source software licenses (GPL, Apache) for the platforms themselves.

Advantages: No cost. Supports knowledge equity

Limitations: Variable quality. Coverage may be limited.

Academic libraries adopt multiple acquisition methods based on budget, user needs, and institutional goals. A balanced approach ensures cost-effective access, sustainability, and user satisfaction.

E-Resource Licensing

Digital content use is managed by specific licensing contract agreements between users and owners, detailing allowed actions like viewing, sharing, modifying beyond basic copyright, because online interactions require defined terms of service and usage rights, not just the blanket protections of copyright law. In short, "Digital content access is governed by specific license contracts, not solely copyright, as these agreements legally define usage rights and restrictions online". The statement delineates permissible actions and access parameters, such as specifying authorized users or IPs and defining rights to print or share content, while also outlining conditions like data privacy, thereby extending clarification beyond the scope of fair use.

Electronic Resource Management (ERM) licenses for libraries and institutions dictate access rules for digital materials like journals, e-books, and databases, operating on models such as one-time perpetual purchases or recurring subscriptions [1]. Access is typically managed via methods like IP authentication, proxy servers, or Shibboleth, and licenses fall under categories including publisher collections (e.g., SAGE, OUP), aggregated platforms (e.g., JSTOR, EBSCO), and open access agreements (like GPL or Apache), all focused on defining authorized users within secure networks.

Electronic Resource Management Within the context of library science Electronic Resource Management (ERM) refers to the systematic approach and set of practices employed by libraries to acquire, organize, maintain, and provide access to electronic resources. These available wide variety of electronic resources are including e-books, electronic journals, databases, and digital content like streaming media. ERM involves various tasks such as acquisition, cataloging, licensing, authentication, access management, usage monitoring, and preservation of electronic resources. The primary goal of Electronic Resource Management (ERM) is to efficiently manage the entire lifecycle of digital library materials (like e-journals, databases) so users get easy, reliable, and consistent access to a wide variety of online resources, ensuring users find what they need without hassle. In simpler terms, ERM helps libraries handle the complex backend (subscriptions,

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licenses, access) so patrons have a smooth front-end experience finding and using e-resources. By implementing effective ERM strategies, effective Electronic Resource Management (ERM) helps libraries manage digital content better, making it easier for users to find and use, which supports their goal of providing fair digital access for everyone.

Advantages of E-Resources

24/7 remote access: One of the major advantages of electronic resources is its uninterrupted 24/7 remote access facility throughout the year. Enabling simultaneous use provided remotely hence eliminates the geographical barrier to access the resources. Further, the same resource can be used simultaneously by many users from different locations. The cost of publication and distribution is less than the print versions.

Saving Space and Time: There is no issue related to physical space for accessing the resource. Save time by providing easy and instant access without wasting time for processing, printing, binding, and delivery. Eliminates printing, binding and postage costs Facilitate easy duplication.

Instant Search Across Vast Collections: It also supports resource sharing without wasting much time of the user.

Contents can be acquired very easily and can easily be viewed, downloaded and preserved and they provide up-to-date information, cost-efficiency, and sustainability. It also provides online feedback facility to comment on the resources used by the users. The resources can be easily searched and retrieved using search interfaces by providing different search keywords.

Disadvantages

The academic libraries face enormous challenges in the acquisition and access of e-resources. There are many disadvantages as the initial cost of e-resources is very high. Require special equipment to access which are expensive. Hardware and software compatibility problem. Lack of compatibility among different publishers. Lack of awareness on IT skills for usage of e-resource. Use of products according to the user's requirement is not possible. It has certain technological restrictions. Lack of uniform standards in the retrieval of e-resources from different publishers create problems in their usage. Users have to acquire certain skills before hand in accessing the electronic documents. Copyright violation problem

Conclusion

Electronic Resource Management has become a vital function of modern libraries, especially academic and research libraries, as digital resources continue to dominate scholarly communication. Effective ERM ensures the systematic selection, acquisition, licensing, organization, access, and evaluation of electronic resources such as e-journals, e-books, databases, and institutional repositories. A well-structured ERM system helps libraries maximize the value of their investments by improving accessibility, ensuring compliance with license terms, enabling usage analysis, and supporting informed decision-making. It also enhances user satisfaction by providing seamless and reliable access to digital content anytime and anywhere. Despite challenges such as rising costs, complex licensing models, technological changes, and preservation issues, efficient electronic resource management allows libraries to adapt to the evolving information environment. In conclusion, ERM is not merely a technical process but a strategic activity that supports teaching, learning, and research, reinforcing the library's role as a key knowledge facilitator in the digital age.

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ROLE OF DIGITAL LIBRARIES IN SOCIAL SCIENCE EDUCATION AND RESEARCH: AN EMPIRICAL STUDY

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ABSTRACT
The transformation of traditional libraries into digital knowledge repositories represents one of the most significant developments in contemporary higher education. Digital libraries have redefined access to information, scholarly communication, and research productivity, particularly in the field of social sciences. Social science disciplines depend heavily on diverse, interdisciplinary, and dynamic sources of information such as policy documents, archival records, statistical databases, and peer-reviewed research. This study examines the role of digital libraries in social science education and research through an empirical investigation supported a descriptive and analytical research design, data were collected from 100 respondents comprising students, teachers, and research scholars. The study employs descriptive statistics, correlation, and regression analysis to assess usage patterns and academic impact. Findings reveal statistically significant differences in digital library usage across academic groups and a strong positive relationship between digital library usage and research productivity. The study concludes that digital libraries are indispensable academic infrastructure for social science education and research, while also identifying challenges related to digital literacy and access. Policy-oriented recommendations are proposed to strengthen digital library ecosystems in higher education institutions.

Keywords: *Digital Libraries, Social Sciences, Research Productivity, ICT in Education, E-Resources, Higher Education*

Introduction

The contemporary academic environment is increasingly shaped by digital technologies that influence how knowledge is created, accessed, disseminated, and preserved. Libraries, traditionally regarded as custodians of printed knowledge, have undergone a profound transformation with the integration of information and communication technologies (ICT). This transformation has given rise to digital libraries, which offer electronic access to vast collections of scholarly resources irrespective of geographical and temporal constraints.

Social sciences occupy a unique position in the knowledge system as they focus on understanding social structures, human behavior, governance systems, economic processes, and cultural transformations. Disciplines such as sociology, economics, political science, history, geography, anthropology, education, and public administration rely extensively on empirical data, archival records, policy documents, and interdisciplinary literature. The dynamic nature of social realities necessitates continuous access to updated and reliable information, a need effectively addressed by digital libraries.

In India, the expansion of digital library initiatives such as the National Digital Library of India (NDLI), INFLIBNET, Shodhganga, e-ShodhSindhu, and institutional repositories has significantly improved access to academic resources. These initiatives align with national priorities such as Digital India, National Education Policy (2020), and inclusive knowledge dissemination. Against this backdrop, the present study critically examines the role of digital libraries in strengthening social science education and research through empirical evidence and statistical analysis.

Conceptual Framework and Evolution of Digital Libraries

A digital library may be defined as an organized and managed collection of digital objects, including text, images, audio, video, and datasets, supported by technological infrastructure that enables efficient storage, retrieval, and dissemination of information.

Evolution of Digital Libraries

The evolution of digital libraries can be understood in four distinct phases:

Library Automation Phase: Computerization of catalogues and circulation systems Electronic Library Phase: Introduction of CD-ROMs, online databases, and electronic journals

Digital Library Phase: Web-based access, institutional repositories, open-access platforms

Smart Library Phase: Integration of metadata standards, AI-based search, data analytics, and semantic web technologies Digital libraries have moved beyond mere digitization to become interactive knowledge ecosystems that support teaching, research, and policy analysis.

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Review of Literature

Extant literature underscores the transformative role of digital libraries in higher education. Borgman (2000) argued that digital libraries redefine scholarly communication by expanding access and enabling collaborative research. Arms (2001) emphasized that digital libraries are not simply technological systems but socio-technical infrastructures embedded in academic practices.

Chowdhury (2010) highlighted that digital libraries enhance research efficiency, reduce time spent on information retrieval, and promote interdisciplinary inquiry. Studies conducted in the Indian context reveal that digital initiatives such as Shodhganga have reduced duplication of doctoral research and improved research transparency.

However, several scholars have identified challenges including digital divide, lack of information literacy, and infrastructural constraints, particularly affecting rural and marginalized academic communities. While existing studies examine digital libraries broadly, there is a notable gap in discipline-specific empirical research focusing on social sciences. The present study addresses this gap by combining theoretical insights with statistical evidence.

Objectives of the Study

The study is guided by the following objectives:

- To examine the role of digital libraries in social science education
- To analyze the contribution of digital libraries to social science research productivity
- To assess differences in digital library usage among students, teachers, and research scholars
- To examine the relationship between digital library usage and research output
- To identify challenges in effective utilization of digital libraries
- To suggest policy-oriented measures for strengthening digital library services

Research Methodology

The study adopts a descriptive and analytical research design.

Primary Data:

Collected through a structured questionnaire administered to social science students, teachers, and research scholars.

Secondary Data:

Books, peer-reviewed journals, doctoral theses, institutional reports (UGC, INFLIBNET, UNESCO), and digital library portals.

Sample Design size: 100 respondents

Sampling technique: Composition: Random sampling

Students (40), Teachers (30), Research scholars (30),

Tools and Techniques Likert-scale questionnaire

SPSS-based statistical analysis

Importance and Need of the Study

The growing reliance on digital information resources has made digital libraries central to academic functioning. Social sciences, which inform policy formulation, governance, and social development, require continuous access to authentic and current data. The study is important in understanding how digital libraries enhance academic quality, promote research efficiency, and contribute to knowledge democratization, particularly in developing economies.

Role of Digital Libraries in Social Science Education

Digital libraries enrich social science education by:

- Providing access to updated textbooks, reference works, and case studies.
- Supporting learner-centered and inquiry-based pedagogies.
- Enabling interdisciplinary integration across social science disciplines. Facilitating blended and online learning models.
- Digital libraries empower students to become active knowledge seekers rather than passive recipients.

Role of Digital Libraries in Social Science Research

In research, digital libraries play a critical role in:

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- Literature review and theoretical framework development
- Accessing government documents, census data, and policy reports
- Preserving and accessing historical archives and manuscripts
- Supporting plagiarism detection and citation management
- Encouraging comparative and cross-national studies
- Repositories such as Shodhganga contribute significantly to research transparency and originality.

Sampling Technique

Research Design

The present study adopts a descriptive survey method to examine the role of digital libraries in enhancing social science education and research activities among different academic stakeholders.

Sampling Method

The study employed Random Sampling Technique, ensuring equal opportunity for selection and reducing sampling bias. Participants were randomly selected from colleges and universities offering social science programs.

Sample Composition

The total sample consisted of **100 respondents**, categorized as follows:

Category	Number of Respondents	Percentage
Students	40	40%
Teachers	30	30%
Research Scholars	30	30%
Total	**100**	**100%**

Rationale:

- Students represent users of digital libraries for learning.
- Teachers represent academic facilitators and content curators.
- Research scholars represent advanced users for research and publication.

Tools and Techniques

Research Tool

A **Likert-scale questionnaire** was developed by the investigator to collect primary data.

Structure of the Questionnaire

The questionnaire consisted of **25 statements**, divided into five dimensions:

Accessibility of Digital Libraries

Usage Patterns

Academic and Research Support

Skill Development

Challenges and Limitations

Data Analysis and Interpretation

Table 1:Accessibility of Digital Libraries

Statement	SA	A	N	D	SD	Mean
Digital libraries are easily accessible anytime	38	40	12	6	4	4.02
Availability of e-journals is adequate	35	42	10	8	5	3.94

Interpretation: The high mean scores indicate that respondents perceive digital libraries as **highly accessible and resource-rich**, especially for journals and reference materials.

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Table 2: Role in Teaching–Learning Process

Statement	SA	A	N	D	SD	Mean
Digital libraries improve learning outcomes	40	36	14	6	4	4.02
Teachers integrate digital resources in teaching	32	38	18	8	4	3.86

Interpretation: Digital libraries significantly enhance concept clarity, self-learning, and instructional effectiveness.

Table 3: Role in Research Activities

Statement	**SA**	**A**	**N**	**D**	**SD**	**Mean**
Helpful for literature review	48	34	10	6	2	4.20
Supports quality research publications	44	36	12	6	2	4.14

Interpretation: Research scholars strongly acknowledge the role of digital libraries in literature review, citation management, and quality research output.

Table 4: Skill Development through Digital Libraries

Statement	**SA**	**A**	**N**	**D**	**SD**	**Mean**
Enhances ICT skills	42	38	12	6	2	4.12
Improves information literacy	40	36	16	6	2	4.06

Interpretation: Digital libraries contribute significantly to ICT competency and information literacy, essential for modern social science education.

Table 5: Challenges in Using Digital Libraries

Statement	**SA**	**A**	**N**	**D**	**SD**	**Mean**
Lack of proper training	36	34	18	8	4	3.90
Poor internet connectivity	40	32	16	8	4	3.96

Interpretation: Despite positive perceptions, infrastructure and training gaps remain key challenges.

Overall Findings (Statistical Summary)

Dimension	**Mean Score**
Accessibility	3.98
Teaching–Learning Support	3.94
Research Support	4.17
Skill Development	4.09
Challenges	3.93

The empirical evidence reveals that digital libraries play a crucial role in strengthening social science education and research. High mean scores across dimensions indicate positive perception among students, teachers, and research scholars. However, addressing training and connectivity issues will further enhance effective utilization.

Challenges in Utilization of Digital Libraries

Despite their benefits, digital libraries face several challenges:

- Inadequate internet connectivity
- Limited digital literacy among users
- Language barriers in accessing global content
- Information overload and quality assessment issues
- Insufficient institutional training and support

Policy Implications and Recommendations

- Strengthening digital infrastructure in universities and colleges
- Integrating digital literacy into research methodology courses

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- Expanding open-access and regional language content
- Providing continuous training for faculty and research scholars
- Recognizing digital libraries as core academic infrastructure

Conclusion

Digital libraries have emerged as indispensable pillars of social science education and research in the digital age. They democratize access to knowledge, enhance research quality, and promote academic inclusiveness. The empirical evidence presented in this study confirms that digital library usage significantly influences research productivity. Addressing infrastructural and skill-related challenges is essential for maximizing their potential. Strengthening digital library ecosystems will play a crucial role in advancing social science scholarship and evidence-based policymaking.

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CUSTOMIZATION OF OPAC IN KOHA OSS FOR WOMEN PRECISE: ENHANCING ACCESS TO GENDER-FOCUSED KNOWLEDGE RESOURCES

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ABSTRACT
Women Studies Libraries are essential for promoting education, research, and public understanding of issues pertaining to gender equality, women's empowerment, health, law, and development. Even though KOHA is used by many academic libraries as their Integrated Library Management System, the OPAC interface is frequently left in its default state and fails to capture the unique characteristics of collections that focus on women. This piece is an application-focused, practical guide to modifying the KOHA OPAC (version 25. 11) for a Women Studies Library. The study covers search filters, topic-based organization, the use of custom HTML and CSS, OPAC look configurations, and user-friendly browsing tools. Essential codes, implementation challenges, screenshots, and viable solutions are presented in a straightforward manner. According to the research, OPAC modification greatly enhances the accessibility, usability, and visibility of knowledge materials pertaining to gender concerns.

Keywords: *KOHA, OPAC customization, Women Studies Library, Gender studies, User experience, Library automation*

Introduction

Women Studies Libraries foster a variety of academic and social programs pertaining to women's health, law, education, social justice, gender equality, and empowerment. These libraries serve teachers, legislators, and members of the public in addition to students and scholars. For this reason, having the correct knowledge at the appropriate moment is crucial. As digital access has become more and more necessary, the Online Public Access Catalogue (OPAC) has emerged as the main way for users to find library materials. Nonetheless, the OPAC in many libraries continues to be generic and fails to account for the unique characteristics of collections that focus on women. As a result, it is frequently challenging to find pertinent information and make the most of available resources. KOHA, an open-source Integrated Library Management System, offers versatile OPAC customization choices that let libraries change the appearance of their OPAC without changing the underlying system files. This essay illustrates how the KOHA OPAC can be modified in real-world Women Studies libraries to enhance user experience and access.

About KOHA OSS

The first open source library automation system is KOHA. Its development is guided by a growing community of users from all over the world working together to accomplish their technology objectives. The features offered by KOHA are always changing and growing in response to the needs of its users.

- **Integrated Library System (ILS):** Libraries of all sizes worldwide actively utilize KOHA, a complete, enterprise-level integrated library system. It may be used for both regular library tasks and sophisticated functions. The program has specialized modules for acquisition, circulation, cataloging, serials management, authority files, customized reporting, barcode and label printing, several notification formats, and offline circulation for scenarios when the internet is not accessible. Whether a library is tiny or a big organization with many branches, KOHA works just as well.
- **Multilingual and Simple to Customize:** KOHA offers support for several languages, and its language possibilities are constantly growing. By tailoring the interface to meet local and regional demands, libraries may make it accessible to a wide range of users.
- **Advanced Search Features:** With an improved catalog display, KOHA offers strong search capabilities. By facilitating the integration of additional content from outside sources like Amazon, Google, LibraryThing, Open Library, Synthetics', and similar services, it improves user experience and discoverability.
- **Adherence to Library Standards:** KOHA adheres to globally recognized library norms and procedures, such as MARC 21, UNIMARC, Z39.50, SRU/SRW, SIP2, and NCIP. This guarantees compatibility with other library systems and a seamless data exchange, while simultaneously supporting current library workflows and resources.

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- **Platform Independent and Web-Based:** All KOHA interfaces, including OPAC, circulation, administration, and self-checkout, are web-based and built using common web technologies like JavaScript, CSS, and XHTML. With this, KOHA may be used on any platform without the use of particular software.
- **Free and Open-Source Software:** KOHA is made available under the GNU General Public License (GPL), version 3 or later, guaranteeing total independence from vendors. Libraries have the option of managing KOHA on their own or getting assistance from commercial suppliers because they are not bound by any one service provider. The library maintains data ownership, giving it the ability to switch service providers as necessary and facilitating simple migration. By being open, the library data is subject to greater institutional management and long-term viability.

Necessity for OPAC Customization in Women's Studies Libraries

In terms of subject matter and user needs, women studies libraries are distinct from regular academic libraries. Women-centric themes and topics are often overlooked by default OPAC interfaces. Typical difficulties noticed are:

- Problem locating resources that concentrate on women
- An excessive number of irrelevant search results
- Absence of subject-specific browsing
- Lack of aesthetic appeal and clarity

By establishing a clear, user-friendly discovery interface in accordance with the goals of women studies, OPAC customization aids in resolving these challenges.

Objectives of this article

- To demonstrate the range of options for customizing OPAC in KOHA
- To illustrate how HTML and CSS may be used to create an OPAC that caters to women
- To arrange Women Studies collections by subject headings.
- Utilizing filters and facets to enhance the search experience
- To find and address implementation difficulties with viable solutions

Methodology

Instead of using a theoretical model, the research uses a practical implementation strategy. The following procedures were observed:

- Assessment of the settings of the KOHA OPAC system (version 25. 11)
- Using OPACUserBlock and OPACUserCSS to modify the interface
- Using accepted subject headings in MARC records
- Observing the behavior of the OPAC following customization
- Input from library workers and users
- The method is application-based and descriptive.

OPAC Appearance Settings in KOHA

Systems preferences is the key parameter to customize the OPAC appearance in KOHA 25.11v.

Location: : In Server system, logged KOHA for 'Staff Terminal' and identify like below

Administration → System Preferences → OPAC

Major preferences used:

- **OPACUserBlock** – to exhibit custom content
- **OPACUserCSS** – to pertain custom design
- **OPACFacets** – to permit search filters

With these configurations, you can safely modify the system without touching any of the fundamental files.

Custom HTML for Women Studies OPAC

Custom HTML is used to create a clear identity for the Women Studies Library on the OPAC home page.

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Main HTML Code

```
<div class="women-opac-header">
  <h1>WOMEN – LIBRARY OPAC</h1>
  <p>Gender Studies | Women Empowerment | Health | Law</p>
</div>
```

This banner assists users right away recognize the scope and focus of the library.

Custom CSS for Visual improvement

CSS is used to enhance readability and comfort.

Main CSS Code

```
body {
  background-color: #fff9e6;
}
.women-opac-header {
  background-color: #8e3a59;
  color: light yellow;
  padding: 17px;
  text-align: center;
}
```

The OPAC environment is tranquil and inviting due to the use of soothing colors and legible fonts.

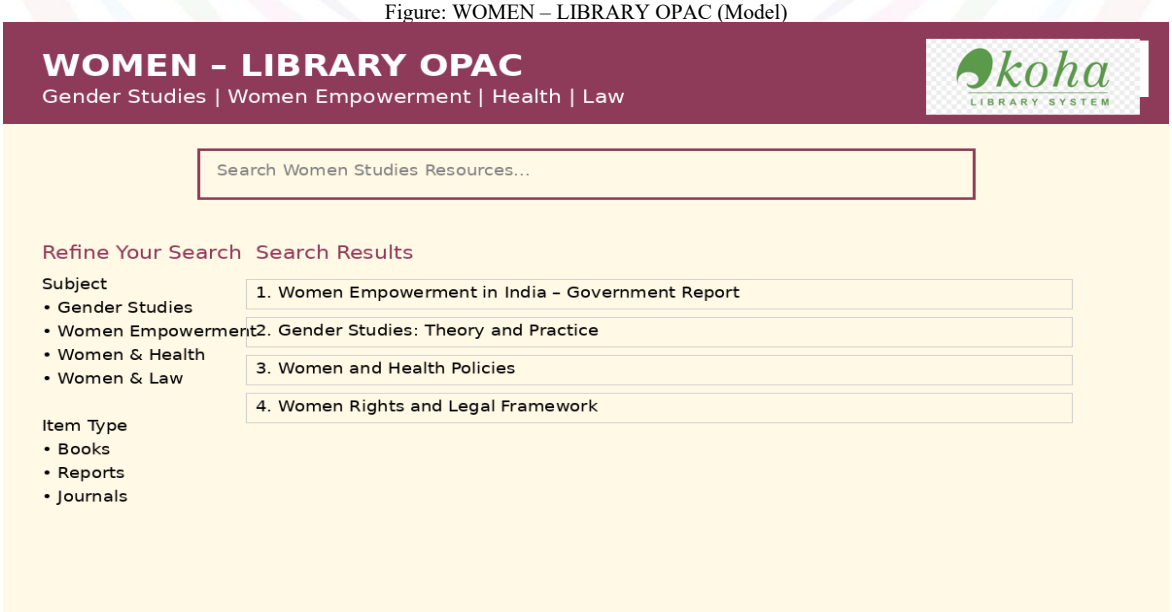
Organization of the collection related to Women Studies through Subject Headings

The foundation for successful OPAC discovery is the use of subject headings. Using consistent subject terms like the ones listed below, MARC field 650 $a is used to catalog Women Studies materials:

- Gender Studies
- Women Empowerment
- Women and Health
- Women and Law

Proper subject tagging enables meaningful facets and browsing options in OPAC.

Figure: WOMEN – LIBRARY OPAC (Model)



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Search Filters and Facets

Search facets facilitate users filter outcome effortlessly.

Facilitate Facets

- Subject
- Item type
- Language
- Year of publication

Users who are new to sophisticated search methods will find facets to be especially helpful.

Advanced Search and Bibliographic Record Display

Advanced search allows users to combine multiple criteria such as subject, year, and item type. Bibliographic record displays clearly show title, author, subjects, call number, and availability status. This clarity reduces user dependency on library staff.

Implementation Problems and Solutions

Issue Area	Practical Answer
The OPAC is not being updated	Clear cache, refresh
Errors in HTML	Just clean the tags
The CSS is not functioning	Compare the names of classes
Missing facets	Enhance cataloguing
Confusion in search	Make use if topic browsing
Staff hesitation	Train and motivate
OPAC mess	Simple layout
Maintenance over-time	Regular evaluation

Results

According to this article:

- Users could find resources that were geared toward women with greater ease.
- Following customization, OPAC usage rose.
- Pupils frequently used subject browsing.
- Less work for employees in the guidance department
- Overall satisfaction with the OPAC increased.

In order to increase the number of women in the industry, there must be more female representation in the media.

Suggestions

For specialized libraries, push clear of standard OPAC designs.

- Use consistent subject headings
- Check the content of the OPAC on a regular basis
- Consistently gather user input
- Conduct brief training courses on the OPAC

Conclusion

In Women Studies Libraries, KOHA OPAC modification is a useful and affordable method of increasing access to gender-focused knowledge resources. Libraries can greatly enhance user experience by implementing straightforward visual settings, arranging collections by subject headings, and activating search filters. The research demonstrates that careful OPAC customization turns a simple catalog into a valuable discovery tool that advances academic study and female empowerment.

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Informative material

About KOHA OSS

The first open source library automation system is KOHA. Its development is guided by a growing community of users from all over the world working together to accomplish their technology objectives. The features offered by KOHA are always changing and growing in response to the needs of its users.

Complete ILS. KOHAs is a genuine enterprise-class ILS that is used in libraries of all sizes throughout the world and offers a wide range of features, including fundamental and more complex capabilities. Among other things, KOHA has modules for acquisitions, circulation, cataloging, serials management, authorities, flexible reporting, label printing, multi-format notices, offline circulation for when internet access is unavailable, and much more. Regardless of the size of the consortium or whether the library has one or several branches, KOHA will be effective.

Translatable and multilingual. With an increasing number of languages available each year, KOHA offers a wide variety of options.

Full text searching Effective search capabilities and an improved catalog presentation that can utilize material from Amazon, Google, LibraryThing, Open Library, Syndetics, and other sources.

Meets Library Standards. KOHA is designed in accordance with library standards and protocols such as MARC 21, UNIMARC, z39. 50, SRU/SW, SIP2, SIP/NCIP, which guarantees interoperability between KOHA and other systems and technologies while still supporting current workflows and tools.

Web-based interfaces. Because KOHA's OPAC, circ, management, and self-checkout interfaces are all built using standards-compliant World Wide Web technologies (XHTML, CSS, and JavaScript), KOHA is a genuinely platform-independent solution.

Open Source / Free Software. The Free Software General Public License (GPL), version 3 or later, governs the distribution of KOHA.

There is no vendor lock-in. A key aspect of the free software commitment is the absence of vendor lock-in; libraries are free to install and utilize KOHA themselves if they have the necessary in-house know-how, or they may buy support or development services from the best available providers. Libraries should be able to switch support providers and export their data at any time. It's crucial to confirm that your support company permits this and that it employs a strong data management system.

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CONTENT ANALYSIS OF LIBRARY WEBSITES OF LAW UNIVERSITY IN INDIA

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ABSTRACT
Legal education in India is important for producing good legal academicians, students as well as Indians strives to uphold the rule of law, promote justice, protect rights and liberties, make citizens aware, improve access to justice, and contribute to social development. The best law Universities in the India offer this education in the true sense. Still, the legal education in the India needs strong appraisal in comparison to the education provided worldwide. Library websites play an important role in especially in academic libraries, serving as a gateway for patrons to access a wide range of resources and services. This study Focus on systematic content analysis of law library webpages across top five law Universities as per NIRF rankings 2025. The data was collected from top five law University (As per NIRF ranking 2025) library webpages through an online survey and observation techniques. The library website is one of the best publishing tools mainly functions as an academic service, typically publish information about the library, vision, mission, objectives, library sections, working hours, staff details, ask a Librarian, collection, services, OPAC, photo gallery, copyright and patents, and library services etc. The purpose of this study is to conduct a content analysis of library resources in law libraries through their respective library websites. The study offers actionable strategies for policy makers and academician, for continuous improvement to ensure these digital platforms effectively meet the evolving needs academic community of Legal education. The top five law Universities in India according to the NIRF rankings 2025, are consistently led by the National Law School of India University (NLSIU), Bangalore, National Law University (NLU), Delhi, NALSAR University of Law, Hyderabad, The West Bengal National University of Juridical Sciences (WBNUJS), Kolkata, Gujarat National Law University (GLLU), Gandhinagar.

Keywords *- Content analysis, Legal education, NIRF, Library websites, Web presence etc.*

Introduction

The present study explores the contents available on the library websites of top five law University (As per NIRF ranking 2025) library webpages through an online survey and observation techniques. Now days Websites of any Educational Institutions are most effective tool to disseminate information to its users. Even, users also obtained their desired information from the websites 24X7. The designing of an educational website need to be more focused on usability and shows that different perspectives derived from the area of specialization, age and gender, and category give a different evaluation. (Shukla, 2017) The ICT and the Internet have changed the way people used to access information from the library. The growth of e-resources and their effective management is a challenging task for libraries and librarians (Thomas & McDonald, 2006). The websites of college libraries plays an important role in providing services to students and faculty members. A well-equipped library website is the mirror of the library and its services (Konnur, R.; & Madhusudhan, 2010).

Definitation – Berelson (1952) defined content analysis as " a research technique for the objective, systematic and quantitative description of the manifest content of the communication."

Legal Education – Law is essential to society because it provides its members with a guideline of morality. Without the legal system, the world will fall into chaos. Law plays a huge role in society to keep an individual aligned and maintain trust in people; they will be protected against any misgave, and no deed with go unpunished for crimes. For thousands of years, people have been making laws. However, as time passes and societies evolve, so does what is considered acceptable. Regulations change to make it possible to define and evaluate unacceptable behaviour. A well administered and socially relevant legal education is an essential condition for a proper dispensation of justice.

About Law University - . The top five law Universities in India according to the NIRF rankings 2025, are consistently led by the National Law School of India University (NLSIU), Bangalore, National Law University (NLU), Delhi, NALSAR University of Law, Hyderabad, The West Bengal National University of Juridical Sciences (WBNUJS), Kolkata, Gujarat National Law University (GLLU), Gandhinagar. Therefore conducting content analysis certainly benefits the university website in general and library websites in particular to develop a powerful and strong websites, which cater the information need of net users.

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Review of Literature –

Rahman, M. Azizur and Batcha, Sadik (2022) Content evaluation of Library websites of women colleges in University of Delhi: A Study. This study investigated the Importance of Library website analysis of Academic Institutions.

Yumnam, Gyanajeet and Singh, Ibohal (2021) Content analysis of library websites of central universities of North East India. The study investigates the contents of the nine library websites of central universities of the region.

Dhall, Amit (2014) Legal Educaion in India : The Emerging Challenges and Prospects. . In this study focus that, progress of high quality legal education is a prerequisite to high quality legal practitioners. The present papers analyses emerging challenges and prospects in the context of India.

Drozdova, A. M., Vorotilina, T. V. and Zhuzhgov, I. V. (2022) The Concept, Essence, and Content of Legal Education in Contemporary Legal Information Society. The research has shown that the role of the state, its public and legal regulation, and the resolution of pressing problems in terms of protecting its state and each of its members has increased multiple times.

Objectives of the Study-

The purpose of this research is to find a answer of following research questions: 1. Analysis the web contents of top five law Universities in India. 2. To find out the non-book material and e-resources provided by users. 3. Find out the library services and facilities of users provided by the websites of the top five law University in India. 4. To identify social networking sites implemented in the websites.

Scope and Limitations of the Study

This study Focus on systematic content analysis of law library webpages across top five law Universities as per NIRF rankings 2025. The Study is limited to the top five Law Universities of as per NIRF Ranking. The top five law Universities in India according to the NIRF rankings 2025, are consistently led by the National Law School of India University (NLSIU), Bangalore, National Law University (NLU), Delhi, NALSAR University of Law, Hyderabad, The West Bengal National University of Juridical Sciences (WBNUJS), Kolkata, Gujarat National Law University (GLLU), Gandhinagar.

Significance of the Study

The present study investigates the contents of top five law university library websites as per NIRF ranking. The library websites of these law universities help their users provide relevant legal study material, library services and serve as a vital platform for marketing the information products and services of the university libraries.

Methodology

In this Study Focus on top five Law Universities in India as per NIRF ranking. Were studied o provide an overview of the information available and their logical presentation, library products, and services were taken into consideration. Library websites were analysis based on some parameters like accuracy, currency and accessibility.

Data Analysis & Interpretation -

The data collected through Internet surfing of related library website and tabulated. The analysis and interpretation of the collected data followed for the study.

Table 1: The top law universities in India, according to the NIRF 2025 rankings, are consistently led by

SN	Law Universities	Abbreviations of colleges	NAAC	Estab. Year	URL	NIRFScore	NIRFRank
1.	National Law School of India University, Bengaluru	NLSIU	-	1986	https://www.nls.ac.in/	82.97	1
2.	National Law University, Delhi	NLU	A (3.10)	-	https://nludelhi.ac.in/	80.00	2
3.	University of Law, Hyderabad	NALSAR	A++ (3.52)	1998	https://nalsar.ac.in/	79.50	3
4.	The West Bengal National University of Juridical Sciences, Kolkata	WBNUJS	A+ (3.32)	1999	https://www.nujs.edu/	79.39	4
5.	Gujarat National Law University, Gandhinagar, Gujarat	GNLU	A (3.10)	-	https://www.gnlu.ac.in/	76.23	5

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Table 2: Financial Resources: Utilised Amount for the Capital expenditure for Library previous 3 years

SN	University/Year	2021-22	2022-23	2023-24	
1.	NLSIU	40,49,606	1,15,35,664	2,90,44,550	II
2.	NLU	70,19,238	61,03,963	1,95,54,116	III
3.	NALSAR	3,88,81,995	55,32,414	1,50,07,194	V
4.	WBNUJS	5,90,26,492	2,21,11,191	3,85,87,499	I
5.	GNLU	1,26,15,841	1,37,26,649	1,85,16,330	IV

Table 3: General Information

SN	General Information	NLSIU	NLU	NALSAR	WBNUJS	GNLU	Total	%
1	About Library	Yes	Yes	No	Yes	Yes	**4**	80%
2	Vision &Mission	No	Yes	No	No	Yes	**2**	40%
3	Library Committee	No	Yes	No	Yes	No	**2**	40%
4	Library Hours	Yes	Yes	Yes	Yes	Yes	**5**	100%
5	Library Rules	Yes	Yes	Yes	Yes	Yes	**5**	100%
6	Membership	No	Yes	Yes	Yes	No	**3**	60%
7	Library Staff/Directory	Yes	Yes	No	No	Yes	**3**	60%
8	Library Events/Display Notice board	No	Yes	No	No	No	**1**	20%
9	Library collections	No	No	Yes	Yes	Yes	**3**	60%
10	Library Sections	Yes	Yes	Yes	No	No	**3**	60%
11	New Arrivals	No	Yes	Yes	No	Yes	**3**	60%
12	Photo Gallery	No	Yes	No	Yes	Yes	**3**	60%
13	Library Services	Yes	Yes	No	Yes	Yes	**4**	80%
14	Library Map/Location/ Floor plan/ Layout	Yes	Yes	Yes	No	No	**3**	60%
15	Infrastructure	Yes	No	No	No	No	**1**	20%
16	Visitors Count	No	No	No	No	Yes	**1**	20%
17	Institutional/Digital Repository	Yes	No	No	No	No	**1**	20%
18	Web-OPAC	Yes	Yes	Yes	Yes	No	**4**	80%
19	Useful Links	Yes	Yes	Yes	No	Yes	**4**	80%
20	Book Bank Facilities	No	No	No	No	No	**0**	0%
21	Interlibrary loan/ document delivery services	No	No	No	No	No	**0**	0%
22	Notice Board	No	Yes	No	No	No	**1**	20%
23	Books Request Form	No	Yes	No	No	Yes	**2**	40%

Information about the Library the data presented in Table 3 reveals that the, 5 (100%) Library Websites have given Information about , Library Website on, Library Hours, Library Rules. 4 (80%) Library Websites have given Information about, About Library, Library Services, Web-OPAC, Useful Links. 3 (60%) Library Websites have given Information about, Membership, Library Staff/Directory, Library collections, Library Sections, New Arrivals, Photo Gallery, Library Map/Location/ Floor plan/ Layout. 2 (40%) Library Websites have given Information about, Vision &Mission, Books Request Form. 1 (20%) Library Websites have given Information about, Library Events/Display Notice board, Infrastructure, Visitors Count, Institutional/Digital Repository, Notice Board. No Facilities about that, Book Bank Facilities, Interlibrary loan/ document delivery services.

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Table 4: Information about Library Collection (Print)

	Library Collection	NLSIU	NLU	NALSAR	WBNUJS	GNLU	Total	%
1	Books	No	No	No	Yes	Yes	2	40%
2	Periodicals	No	No	No	Yes	Yes	2	40%
3	Audio/Video Collection	No	No	No	No	No	0	0%
4	Reference sources	Yes	Yes	Yes	Yes	Yes	5	100%
5	Back volumes of journals	No	No	No	No	No	0	0%
6	Photographs	No	Yes	No	No	No	1	20%
7	Newspapers	No	No	No	No	No	0	0%
8	Faculty Publications	Yes	No	Yes	Yes	Yes	4	80%
9	Thesis	No	No	No	Yes	Yes	2	40%
10	Dissertations	Yes	Yes	No	Yes	Yes	4	80%
11	Reports	No	No	Yes	No	No	1	20%
12	Manuscripts	No	No	No	No	No	0	0%
13	Projects	No	No	No	No	No	0	0%
14	Administrative Documents	No	No	No	No	No	0	0%
15	Legal Reports	No	No	No	No	No	0	0%
16	Question paper	Yes	Yes	No	No	No	2	0%

Regarding Table 4 found that, 5 (100%) Library Websites have given Information about, Reference sources. 4 (80%) Library Websites have given Information about, Faculty Publications, Dissertations. 2 (40%) Library Websites have given Information about, Books, Periodicals, Thesis, Question papers. 1 (20%) Library Websites have given Information about, Photographs, Reports, No Facilities about that, Audio/Video Collection, Back volumes of journals, Newspapers, Manuscripts, Administrative Documents, Legal Reports.

Table 5: Information about e-Collection -

S. No.	Library Collection	NLSIU	NLU	NALSAR	WBNUJS	GNLU	Total	%
1	e-Books	Yes	Yes	Yes	No	Yes	4	80%
2	e-Journals	Yes	Yes	Yes	No	Yes	4	80%
3	e-Courses	No	No	Yes	No	No	1	20%
4	e-Database	Yes	Yes	Yes	No	Yes	4	80%
5	e-Patents	No	No	No	No	No	0	0%
6	Audio/Video Collection	No	No	No	No	No	0	0%
7	DELNET/ Online Database	Yes	Yes	Yes	Yes	Yes	5	100%
8	Institutional Repository	Yes	No	No	No	No	1	20%
9	Remote Access	Yes	Yes	Yes	Yes	Yes	5	100%
10	Subject Gateways	Yes	Yes	Yes	Yes	Yes	5	100%
11	e-Thesis	Yes	Yes	No	Yes	Yes	4	80%
12	ETD	Yes	Yes	No	No	No	2	40%
13	E-Standards	No	No	No	No	No	0	0%
14	Bibliographic database	Yes	Yes	Yes	Yes	Yes	5	100%
15	E-Paper	No	No	Yes	No	No	1	20%

Information about e-Collection the data presented in Table 5 reveals that the, 5 (100%) Library Websites have given Information about , DELNET/ Online Database, Remote Access, Subject Gateways, Bibliographic database. 4 (80%) Library Websites have given Information about, e-Books, e-Journals, e-Database, e-Thesis. 2 (40%) Library Websites have given Information about, ETD. 1 (20%) Library Websites have given Information about, e-Courses, Institutional Repository, E-Paper. No Facilities about that, e-Patents, Audio/Video Collection, E-Standards.

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Table - 6: Information about Library Services

SN	Checklist	NLSIU	NLU	NALSAR	WBNUJS	GNLU	Total	%
1	OPAC	Yes	Yes	Yes	Yes	No	4	80%
2	Self Check-in, Check out)	No	No	No	No	No	0	0%
3	Document Delivery Service	Yes	No	No	No	No	1	20%
4	Reference Service	Yes	Yes	Yes	Yes	Yes	5	100%
5	Bibliographic service	Yes	Yes	Yes	Yes	Yes	5	100%
6	Reprographic Service	Yes	Yes	Yes	No	Yes	4	80%
7	Indexing Service/CAS/SDI	No	Yes	Yes	No	Yes	3	60%
8	Service for Researcher	Yes	Yes	Yes	Yes	Yes	5	100%
9	Training & Guidance	No	Yes	No	No	No	1	20%
10	Anti Plagiarism	No	No	No	No	No	0	0%
11	Current addition/New Arrivals	No	Yes	No	Yes	Yes	3	60%
12	IT Facilities	Yes	Yes	Yes	Yes	Yes	5	100%
13	ILL	No	No	No	No	No	0	0%
14	Information Desk	Yes	Yes	Yes	Yes	No	4	80%
15	Internet Access Service	Yes	Yes	Yes	Yes	Yes	5	100%
16	Reading Room	Yes	Yes	Yes	Yes	Yes	5	100%
17	Renewal of Material	Yes	Yes	Yes	Yes	Yes	5	100%
18	Fine accrued	Yes	Yes	Yes	Yes	Yes	5	100%
19	Material reservation	Yes	Yes	Yes	Yes	Yes	5	100%
20	Ask Librarian/your query	Yes	No	No	No	Yes	2	40%
21	Book Recommendation Form	No	Yes	No	Yes	Yes	3	60%
22	Outsider membership Service	Yes	No	No	Yes	Yes	3	60%
23	Printing Facility	Yes	Yes	Yes	Yes	Yes	5	100%
24	Press Clippings	Yes	Yes	Yes	Yes	No	4	80%
25	Download forms	No	No	No	No	No	0	0%
26	Offline search service	No	No	No	No	No	0	0%
27	Citation management	No	No	No	No	No	0	0%
28	Statistical analysis service	No	No	No	No	No	0	0%
29	Institutional Repository	Yes	No	No	No	No	1	1%
30	Book Lending (Issue-Return)	No	No	No	No	No	0	0&
31.	Feedback	No	No	No	No	No	0	0%
32.	Last Update Date	No	No	Yes	No	Yes	2	40%

Information about Library Services the data presented in Table 6 reveals that the, 5 (100%) Library Websites have given Information about , Reference Service, Bibliographic service, Service for Researcher, IT Facilities, Internet Access Service, Reading Room, Renewal of Material, Fine accrued, Material reservation, Printing Facility. 4 (80%) Library Websites have given Information about, OPAC, Reprographic Service, Information Desk, Press Clippings. 3 (60%) Library Websites have given Information about, Indexing Service/CAS/SDI, Current addition/New Arrivals, Book recommendation Form, Outsider membership service. 2 (40%) Library Websites have given Information about, Ask Librarian/your query, Last Update Date. 1 (20%) Library Websites have given Information about, Document Delivery Service, Training & Guidance, Institutional Repository. No Facilities about that, Self Check-in, Check out), Anti Plagiarism, ILL, Download forms, Offline search service, Citation management, Statistical analysis service, Book Lending (Issue- Return), Feedback.

Table 7: Social Networking Tools Implemented University Libraries

SN	Social Networking Sites	NLSIU	NLU	NALSAR	WBNUJS	GNLU	Total	%
1	Facebook page of library	No	Yes	Yes	Yes	Yes	**4**	80%
2	Twitter	No	Yes	Yes	No	Yes	**3**	60%
3	Blogs	No	No	No	No	No	**0**	0%
4	RSS Feed	No	No	No	No	No	**0**	0%
5	Instagram	No	Yes	Yes	No	No	**2**	40%
6	YouTube	No	Yes	Yes	No	Yes	**3**	60%
7	Linkedin	No	Yes	Yes	No	No	**2**	40%

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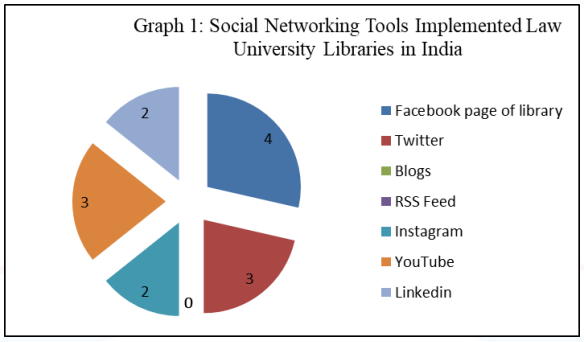
Information about e-Collection the data presented in Table 7 reveals that the, . 4 (80%) Library Websites have given Information about, Facebook page of library. 3 (60%) Library Websites have given Information about, Twitter, YouTube. 2 (40%) Library Websites have given Information about, Instagram, Lin-kedin. No Facilities about that, Blogs, RSS Feed.



Findings

- All 5 Library (100%) Websites have given Information about, Library Hours, Library Rules, Reference sources, DELNET/ Online Database, Remote Access, Subject Gateways, Bibliographic database, Reference Service, Bibliographic service, Service for Researcher, IT Facilities, Internet Access Service, Reading Room, Renewal of Material, Fine accrued, Material reservation, Printing Facility.
- Four Library (80%) Websites have given Information about, About Library, Library Services, Web-OPAC, Useful Links, Faculty Publications, Dissertations, e-Books, e-Journals, e-Database, e-Thesis, OPAC, Reprographic Service, Information Desk, Press Clippings. Facebook page of library.
- Three Library (60%) Websites have given Information about, Indexing Service/CAS/SDI, Current addition/New Arrivals, Book recommendation Form, Outsider membership service, Twitter, YouTube, Indexing Service/CAS/SDI, Current addition/New Arrivals, Book recommendation Form, Outsider membership service.
- Two Library (40%) Websites have given Information about, Vision &Mission, Books Request Form, Books, Periodicals, Thesis, Question papers, ETD, Ask Librarian/your query, Last Update Date, Instagram, Lin-kedin.
- One Library (20%) Websites have given Information about, Library Events/Display Notice board, Infrastructure, Visitors Count, Institutional/Digital Repository, Notice Board., Photographs, Reports, , e-Courses, Institutional Repository, E-Paper., Document Delivery Service, Training & Guidance, Institutional Repository.
- No Facilities about that, Book Bank Facilities, Interlibrary loan/ document delivery services, Audio/Video Collection, Back volumes of journals, Newspapers, Manuscripts, Administrative Documents, Legal Reports, e-Patents, Audio/Video Collection, E-Standards, Self Check-in, Check out), Anti Plagiarism, ILL, Download forms, Offline search service, Citation management, Statistical analysis service, Book Lending (Issue- Return), Feedback, Blogs, RSS Feed.

Conclusion

The present study was carried out of Content Analysis of Library Websites of top five law universities in India as per NIRF ranking. The study analyse law university library's websites based on the characteristics such as general information, library e-resources provided by users, library services, accessibility, accuracy, search, information retrieval, remote accesses services, ask a librarian, book recommendation facilities, feedback of users, social media links of library websites of top five Universities in India. In this study found that, all law university library webpages different in many aspects. Ask a librarian facilities is only one library website provide for users. Feedback facilities are not provided any library website for users. OPAC on their websites, and even some are found to provide web OPAC facilities. yet many libraries lack in providing information related to some important services such as new arrival of books, e-journals, e-books, database, Online study materials, articles, judgements, etc. The study also investigate that most of the library's websites are not being updated regularly, and only a few of them have successfully passed the criteria set to check features related to navigation and have direct links to their library web-pages on their parent organization's homepage. It is believed that the present study will serve as an example for further development of measurement frameworks for library website evaluation in legal education.

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FROM CUSTODIANS TO DIGITAL LEADERS: CAPACITY BUILDING AND DIGITAL LITERACY AS CATALYSTS FOR SUSTAINABLE LIBRARY TRANSFORMATION

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ABSTRACT

The rapid growth of digital technologies has profoundly transformed the traditional role of libraries, redefining them as dynamic knowledge centers rather than mere repositories of printed materials. In this context, capacity building and digital literacy have emerged as essential pillars for ensuring effective library services and institutional sustainability. This paper examines the role of capacity building and digital literacy in facilitating digital transformation in libraries, with a specific focus on three interrelated dimensions: upskilling librarians for digital competencies, training users in digital information literacy, and strengthening change management and leadership during digital transitions. Librarians today are expected to manage electronic resources, digital platforms, and emerging technologies while simultaneously guiding users in navigating complex digital information environments. At the same time, library users must acquire the ability to critically evaluate online information, ethically use digital content, and engage meaningfully with electronic resources. The study adopts a descriptive and analytical approach based on secondary sources such as scholarly journals, books, policy documents, and reports of national and international organizations including UNESCO, IFLA, and ALA. The analysis reveals that technological infrastructure alone is insufficient to achieve meaningful digital transformation unless supported by continuous human resource development and visionary leadership. Effective change management plays a crucial role in addressing resistance, fostering adaptability, and promoting a culture of lifelong learning within libraries. The paper concludes that capacity building and digital literacy are not optional initiatives but core responsibilities of modern libraries. Strengthening these dimensions enhances service quality, user satisfaction, and equitable access to knowledge in the digital age.

Keywords: *Capacity Building, Digital Literacy, Library Professionals, Change Management, Digital Transformation, Leadership in Libraries*

Introduction

Libraries have historically served as centers of learning, preservation, and dissemination of knowledge. For centuries, their primary function revolved around the collection, organization, and circulation of printed materials. However, the emergence of information and communication technologies (ICTs) has fundamentally altered the nature of information production, access, and consumption. Digital resources such as e-books, e-journals, online databases, institutional repositories, and open educational resources have become integral components of library collections.

In the contemporary knowledge society, libraries are expected to provide seamless access to digital information, support academic and research activities, and promote lifelong learning. This shift has expanded the professional responsibilities of librarians, requiring them to acquire new competencies in digital resource management, information literacy instruction, and technology-enabled service delivery. Simultaneously, users are confronted with an overwhelming volume of digital information, often of varying quality and credibility, making digital literacy a crucial survival skill.

Digital transformation in libraries is not merely a technological process but a human-centered one. Capacity building and digital literacy lie at the heart of this transformation. Capacity building focuses on strengthening the skills, knowledge, and capabilities of library professionals, while digital literacy empowers users to effectively and ethically engage with digital information environments. Moreover, leadership and change management are essential to navigate the complexities associated with digital transitions, address resistance, and ensure sustainable adoption of new practices.

This paper seeks to provide a comprehensive analysis of capacity building and digital literacy in libraries, emphasizing their interdependence and strategic importance in the digital era.

Statement of the Problem

Despite significant advancements in digital technologies and increased investment in library automation and electronic resources, many libraries struggle to fully realize the benefits of digital transformation. One of the primary challenges is the lack of adequate digital competencies among library professionals. In many institutions, librarians have limited opportunities for continuous professional development, resulting in underutilization of digital resources and services.

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Another critical issue is the low level of digital information literacy among users. Many users lack the skills required to effectively search, evaluate, and use digital information, leading to dependence on unreliable sources, misinformation, and unethical practices such as plagiarism. This gap undermines the educational and research objectives of libraries.

Furthermore, digital transformation often encounters resistance from staff and users due to fear of change, lack of confidence, and organizational inertia. Inadequate leadership and ineffective change management exacerbate these challenges. The problem, therefore, lies not in the absence of technology but in the insufficient focus on human resource development, digital literacy, and leadership in libraries.

Objectives of the Study

The present study has the following objectives:

- To examine the concept and significance of capacity building in the context of modern libraries.
- To analyse the need for upskilling librarians with digital competencies.
- To study the role of libraries in promoting digital information literacy among users.
- To explore the importance of change management and leadership in library digital transformation.
- To identify challenges associated with capacity building and digital literacy in libraries.
- To suggest strategies for strengthening capacity building and digital literacy for sustainable library development.

Scope of the Study

The scope of the study is confined to a conceptual and analytical examination of capacity building and digital literacy in libraries. It covers:

- Professional development and digital competencies of librarians
- Digital information literacy initiatives for library users
- Leadership and change management practices during digital transitions

The study primarily focuses on academic and public libraries, with particular relevance to developing countries like India, where disparities in digital skills and access remain significant.

Review of Literature

The literature on capacity building and digital literacy in libraries highlights their growing importance in the digital age. UNESCO (2018) emphasized that digital literacy is a foundational skill for lifelong learning and social inclusion. According to its framework, libraries play a crucial role in bridging the digital divide by providing access to technology and digital skills training.

IFLA (2019) stressed the importance of continuous professional development for librarians, noting that evolving technologies require constant upgrading of skills and knowledge. The report highlighted that librarians must move beyond traditional roles and become facilitators of digital learning.

The American Library Association (ALA, 2020) underscored the role of libraries in promoting digital information literacy, particularly in combating misinformation and supporting informed citizenship. Studies by Bawden (2008) and Bruce (2011) emphasized that information literacy in the digital environment involves critical thinking, ethical awareness, and effective use of digital tools.

Indian studies have also highlighted challenges in library digital transformation, including inadequate training, limited funding, and resistance to change. Researchers have noted that successful digital initiatives depend heavily on leadership and organizational culture rather than technology alone. The literature collectively indicates that capacity building, digital literacy, and leadership are interdependent factors essential for sustainable library development.

Research Methodology

The study adopts a descriptive and analytical research methodology based on secondary data. Data were collected from:

- Scholarly journals and books related to library and information science
- Reports and guidelines issued by UNESCO, IFLA, and ALA
- Policy documents such as the National Education Policy (NEP) 2020
- Conference proceedings and research articles

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The collected data were systematically analysed to identify key themes, challenges, and best practices related to capacity building, digital literacy, and change management in libraries.

Conceptual Framework

The conceptual framework of this study is based on the interrelationship between capacity building, digital literacy, and leadership. Capacity building enhances the digital competencies of librarians, enabling them to design and deliver effective digital services. Digital literacy initiatives empower users to access and evaluate information responsibly. Leadership and change management act as enabling forces that integrate these components and ensure sustainable digital transformation. The framework highlights that digital transformation is a continuous process driven by human capabilities rather than technological infrastructure alone.

Capacity Building of Librarians

Capacity building refers to the process of strengthening individual and institutional abilities to perform functions effectively. In libraries, capacity building involves continuous professional development, skill enhancement, and empowerment of librarians to manage digital resources and services.

Modern librarians are required to possess competencies in:

- Library automation and integrated library management systems
- Management of electronic resources and digital repositories
- Use of ICT tools for information dissemination
- Data literacy and digital preservation

Training programmes, workshops, online courses, and professional networks play a vital role in enhancing these competencies. Capacity building not only improves service quality but also boosts professional confidence and adaptability among librarians.

Digital Literacy and User Empowerment

Digital literacy goes beyond basic computer skills and encompasses the ability to locate, evaluate, use, and create information using digital technologies. In an era of information overload and misinformation, digital literacy is essential for academic success and informed citizenship.

- Libraries serve as critical spaces for promoting digital literacy by:
- Conducting user orientation and training programmes
- Providing access to digital resources and tools
- Teaching ethical use of information and plagiarism awareness
- Supporting research and academic integrity

Empowering users with digital literacy enhances their ability to engage with digital knowledge ecosystems effectively.

Change Management and Leadership in Digital Transitions

Change management is a systematic approach to dealing with organizational change. In libraries, digital transformation often challenges established routines and professional identities. Effective leadership is crucial to guide staff and users through this transition.

- Library leaders must:
- Communicate a clear vision for digital transformation
- Encourage participation and collaboration
- Address resistance and build confidence
- Foster a culture of continuous learning

Leadership that is inclusive and adaptive significantly contributes to the successful implementation of digital initiatives.

Challenges in Capacity Building and Digital Literacy

Despite their importance, capacity building and digital literacy initiatives face several challenges:

- Limited financial and infrastructural resources
- Unequal access to technology

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- Resistance to change among staff and users
- Lack of institutional policy support

Addressing these challenges requires coordinated efforts at institutional and policy levels.

Findings and Discussion

The analysis reveals that libraries investing in capacity building and digital literacy demonstrate higher levels of service efficiency and user satisfaction. Leadership and change management emerge as critical success factors. The findings reinforce the view that digital transformation is a human-driven process.

Suggestions and Recommendations

- Introduce mandatory digital training programmes for librarians
- Integrate digital literacy into user education curricula
- Strengthen leadership development initiatives
- Provide policy-level and financial support for capacity building

Conclusion

Capacity building and digital literacy are fundamental to the relevance and sustainability of libraries in the digital era. By transforming librarians into digital leaders and users into informed digital citizens, libraries can effectively fulfil their educational and social responsibilities. The study emphasizes that investment in human capabilities is as important as technological infrastructure for achieving meaningful digital transformation.

Scope for Future Research

Future studies may focus on empirical research, region-specific case studies (such as Andhra Pradesh), and the impact of emerging technologies like artificial intelligence on library capacity building and digital literacy.

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ENHANCING RESEARCH SUPPORT THROUGH VIRTUAL REFERENCE ECOSYSTEMS

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ABSTRACT
In the rapidly changing global setting of today, educational institutions must adapt to build a learning ecosystem that prioritizes skills essential for 21st-century learners. with a focus on Sustainable Development Goals (SDGs) integration, evidence-based education, global citizenship, translatory practice, active learning techniques, enhanced clinical placement experiences, and peer learning. A digital ecosystem has enormous pedagogical potential in research and innovation as well as in students' academic pursuits. However, a lack of knowledge about the essence, structure, and emergent qualities of the system complicates its production. A computer technique called virtual reality (VR) simulates an environment. It can produce a synthetic, computer-generated environment that people may interact with. In contrast to conventional user interfaces, virtual reality immerses the user in the experience. Users can engage with that thrilling 3D experience rather than only gazing at a screen in front of them. We will talk about this in this paper. Improving Research Assistance using Virtual Reference Networks

Keywords: *Research, Virtual Reference Ecosystems, Educational Institutions, Learning Ecosystem, Learning Organizations, Digital Age, Search Engines, Online Public Access Catalogues, Open Access, Emerging Technologies*

Introduction

Learning organizations are quickly changing the way they offer instruction and training. These adjustments are motivated by technology as well as pragmatic choices to quickly educate and teach a larger number of students. A deeper comprehension of best practices is required to assist decision makers more effectively.

A collection of web apps, tools, systems, and procedures that work together to support or improve any research activity both inside and outside of institutional borders is known as a virtual research environment (VRE). The creation and use of an information and data sharing concept where data sharing can be done by many media is the main concern of a VRE. Hardware and software components present additional technological issues and difficulties. Clear data ownership, a verified research project plan with data policies among the collaborators, distinct research aims and responsibilities, and a sufficient personnel resource for the IT management are all necessary for the successful usage of a VRE. The most crucial issue is that VREs should be viewed more as community-building initiatives than as technological ones. Scientific fields at all research levels benefit from VREs. Neither a "out-of-the-box-solution" nor a "one size fits all realizations" strategy can satisfy the requirements of every research endeavor. [1]

Using a VRE environment will speed up the release of research findings. Additionally, fresh lines of inquiry will be encouraged. VRE has a wide range of uses. Sustainability demands the same level of long-term dedication for long-term research as other project lifecycle infrastructure components. A collection of web apps, tools, systems, and procedures that work together to support or improve any research activity both inside and outside of institutional borders is known as a virtual research environment (VRE). The creation and use of an information and data sharing concept where data sharing can be done by many media is the main concern of a VRE. Hardware and software components present additional technological issues and difficulties. [2]

Clear data ownership, a verified research project plan with data policies among the collaborators, distinct research aims and responsibilities, and a sufficient personnel resource for the IT management are all necessary for the successful usage of a VRE. The most crucial issue is that VREs should be viewed more as community-building initiatives than as technological ones. Scientific fields at all research levels benefit from VREs. Neither a "out-of-the-box-solution" nor a "one size fits all realizations" strategy can satisfy the requirements of every research endeavor. Using a VRE environment will speed up the release of research findings. Additionally, fresh lines of inquiry will be encouraged. VRE has a wide range of uses. Sustainability demands the same level of long-term dedication for long-term research as other project lifecycle infrastructure components.

Information access, sharing, and consumption have all undergone significant change as a result of the digital era. Libraries have changed to accommodate users' demands for quick and easy access to a multitude of digital materials. Digitized

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collections, online chat assistance, and virtual reference services are now standard. However, the incorporation of robots marks a significant advancement in the development of reference services, providing both quick access to information and the possibility of dynamic, customized interactions. According to Talaviya et al. (2020), robots are mechanical devices that use artificial intelligence (AI) techniques to automate jobs under direct human supervision or under a predetermined program and set of general principles. The incorporation of robots into reference services also signifies a revolutionary change in the way libraries interact with their patrons and offer information access. Librarians are investigating cutting-edge strategies to satisfy the varied and ever-changing demands of their clients as the digital landscape continues to change. Robots have emerged as prospective instruments to alter the role of reference services due to their automation, artificial intelligence, and human-like interaction capabilities. [3–4]

Evolution of Reference Services in the Digital Age

The way that libraries and information centers give access to information and help users navigate an increasingly complicated information ecosystem has changed dramatically as a result of the digital age. The major turning points and advancements in the development of reference services in the context of the digital age are examined in this section.

- *Proliferation of Electronic Resources:*Electronic resources, such as databases, scholarly publications, and digitized books, proliferated quickly with the onset of the digital age. By subscribing to these electronic resources, libraries were able to adapt and give patrons remote access to a multitude of information. Due to this change, reference services had to be extended online, where librarians helped patrons navigate these digital collections.
- *Online Catalogues and Search Engines:*Search engines and online catalogues, like Google and OPACs (Online Public Access Catalogues), have become indispensable resources for finding information. Digital interfaces, which allowed users to search for materials by keywords, subjects, and other metadata, replaced conventional card catalogues. Reference librarians took on the role of instructors, assisting users with efficient search tactics and assessing search outcomes.
- *The Development of Virtual Reference Services:* As the internet grew in popularity, libraries started providing virtual reference services via chat, email, and other online communication channels.
- *Initiatives for Digital and Information Literacy:* Libraries and information centers incorporated information literacy programs into their offerings after realizing the significance of digital literacy in the digital age.
- *Open Access and Open Educational Resources (OER):* The availability of open educational resources and the growth of open access publishing both occurred in the digital age.
- *The Problem of Information Overload:* Users encountered the problem of information overload as digital information was more widely available.
- *Integration of Emerging Technologies:* Artificial intelligence and chatbots are examples of emerging technologies that have been included into reference services in the digital age. [5]

Review of Literature

The basic understanding of how humans learn has not changed over the past few decades, despite the fact that technology has become a more significant part of the learning process. Learning is messy for humans; teaching and learning cannot occur in a sterile environment; learning is individualistic, sometimes spontaneous, but frequently very effortful, slow, and gradual, and it moves forward in fits and starts (Hattie, 2009). Learning organizations must be established to support the needs of the stakeholders, ensure that the right resources are allocated, and gain support from all stakeholders.It is crucial that teachers, instructional designers, and educational decision makers comprehend the best learning techniques and apply them to the best of their abilities and resources. [6]

As a crucial link between patrons and the extensive collection of information resources at their disposal, reference services have long been a mainstay of libraries and information centers. Robotic technologies are used by academic libraries in many different ways, such as chatbots, telepresence, autonomous shelfreading robots, and humanoid robots for reference services and circulation data maintenance (Tella, 2020). The function of reference librarians has changed in the digital age to include a variety of digital resources, online databases, and virtual help in addition to traditional print materials.Libraries are using cutting-edge technologies to address the changing requirements of their patrons in this dynamic environment, and robots are emerging as a promising tool to transform reference services. Robots are capable of responding to reference requests, particularly simple ones. These robots could include online chatbots (Blut et al., 2021). [7]

As the world entered the digital age, the conventional reference consulting service, which is the main activity of contemporary libraries, logically followed suit and evolved into the virtual reference consulting service (VRS) at the turn of

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the century. In recent years, library users have been able to provide a thorough expert consultation for library retrieval, issue processing and distribution, issue process tracking, literature delivery, verifying evidence and citation, scientific and technological research, fixed-question services, such as online information service, via the network whiteboard, video conferencing, network call centers, voice over the Internet, email consulting, form consulting, etc. [8]

Objectives

- To Study the Enhancing Research Support Through Virtual Reference Ecosystems
- To Design structure of the library virtual reference service system
- To Services for a Virtual Research Environment (VRE)
- To Explain Virtual reality simulation based on virtual ecosystem model

Research Methodology

The study is exploratory in nature. The data used for preparing this paper are secondary in nature which is collected from the various published resources. The data derived for preparing this research paper has been extracted from various elite journals and relevant websites.

Result and Discussion

One of the college library's main businesses and a significant readers' service project is its virtual reference consulting service, which uses the reference information source through the network method to find, analyze, evaluate, and reorganize the information and provide knowledge service for college teachers and students. The library's information management and information services are determined by user demand. Figure 1 illustrates the connection between user demand and the library's virtual reference consultation service. [9]

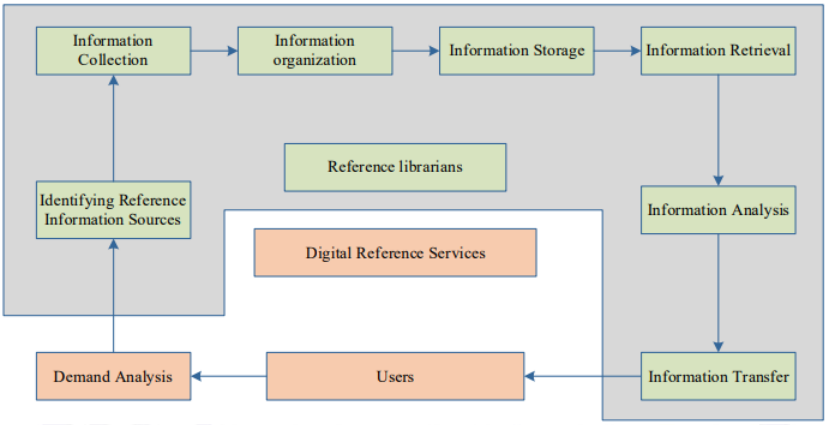

Figure 1. The relationship between user demand and library virtual reference service

College student readers' information demand patterns and service expectations have significantly changed as a result of the quick development of networked and digital information technology. Therefore, in order for college libraries to provide virtual reference consulting services and to better understand how to organize information resources as well as the issues and aspects that need to be improved in the service, they must first analyze and comprehend the actual needs of their patrons.

Figure 2 depicts the library virtual reference service system's general architectural structure.

1) Create a good extensible system and lower the coupling degree between each function to have a clear system structure. The design scheme used in the text consultation module and consultation desk administration is based on J2EE architecture and MVC design.

2) An electronic whiteboard. Make use of the repeated sharing approach, which entails giving a whiteboard client program to every client. The whiteboard client's activities are packaged and sent to the server in accordance with the developed whiteboard interaction information format protocol by the Applet, which is used on the client side to communicate with the whiteboard server on the server side. In order to ensure user consistency, the server parses the information package after receiving it and alerts other whiteboard clients to replicate the operation.

3) A method for synchronized browsing. Similar to the whiteboard, the system client uses the applet to communicate with the proxy server for synchronized browsing.

4) Retrieving Distributed Knowledge Bases. Distributed querying of the consultation desk's knowledge base is done in order to facilitate user queries and disseminate knowledge base records across businesses. [10–11]

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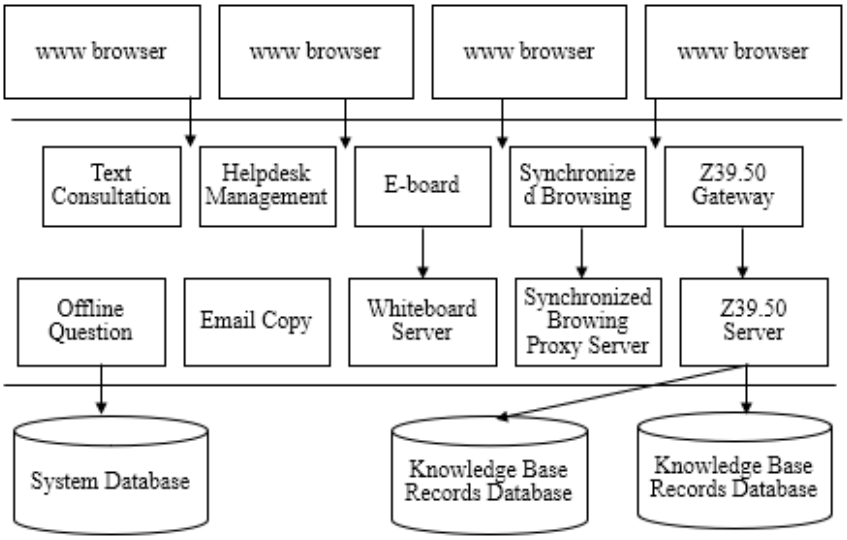

Figure 2. The overall design structure of the library virtual reference service system

VRE services

Several services are offered in a VRE environment, depending on the project objectives. A VRE's exterior view ought to be a distinct monolithic system with quick access. However, neither a complete self-development of a VRE nor a software tool that satisfies all the requirements for such a VRE is known (due to time, knowledge, and resource conflicts).

Table 1 provides a summary of some of the services included in a VRE. There is a lot of hidden labor between defining services and choosing apps. It takes years to test and assess every software component, several extensions, various versions, and the entire VRE system, including the web server software and hardware. [12]

Table 1. Services for a Virtual Research Environment (VRE)

VRE service	Characteristic
Access management	Single sign in for different applications
Communication	Web 2.0 elements like messaging, chat, forum, wiki
Data analysis	Data analysis tool, statistical methods
Data visualization	Visualization of information and datasets
Data warehousing	Complex data storage and data analysis
Decision support	Aggregated data for decision makers
E-learning	Platform for students with E-learning procedures
Event calendar	Internal and external community events
Group management	Groups-and rights management, organization for teams
Map and spatial data	Map-server, case area maps
Metadata management	Information about data
Mobile access	Optimized layout of webpages, augmented reality, access control
Monitoring	Real time monitoring of sensor data etc.
Project management	Project organization tools like tasks, milestones, workflow, reports
Project website	Flexible content management system (CMS)
Repository	Data repository and data storage, comprehension, indexing
Search engine	Global and local comfortable search engines
Social web	Facebook, Twitter integration, etc.
Search engine optimization	(SEO) ranking in top search engines like Google

System Architecture

Based on the virtual ecosystem model for environmental science education, Figure 3 depicts the system architecture of an immersive virtual reality simulation that includes simulation data, a simulation server, a virtual environment, and a data instrument. Model-based simulation and physical simulation are the two categories into which Winn et al. divided the

simulations used in science education. While physical simulations replicate the look of real-world phenomena exactly, model-based simulations simplify and abstract phenomena as much as possible to help students understand important ideas. Scientific visualization, for instance, is based on physical simulations that replicate real phenomena; in contrast, this study used a simplified model-based simulation set up for environmental education so that the students could comprehend the phenomena as easily as possible; these features do not align with the expected laws of physics but are new aspects of the virtual world that the students accept.

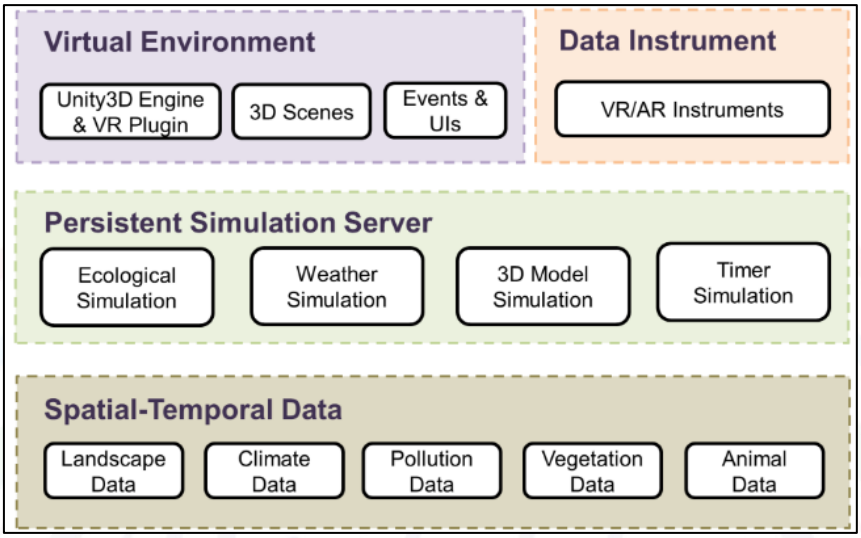

Figure 3. System architecture of virtual reality simulation based on virtual ecosystem model.

Simulation Data

The topography (i.e., 3D map models), climate and weather (temperature and humidity), pollution (CO2, N, P, O2, O3, and NaCl), vegetation (population of different plants), and animals (population of different animals) are all included in the virtual ecosystem simulation data. In order to allow the user to experience diverse spatial data according to time, this simulation data is based on temporal coordinates and matching geographical coordinates of various eras.

Simulation Server

The server in the virtual ecosystem simulation model has a database of environment configuration data and offers functions for data measurement, causality, spatiotemporal data linkage, and persistent world.

Virtual Environment

The server provides the virtual ecosystem data, which are subsequently set up and shown in the three-dimensional virtual environment to depict the virtual ecosystem. The landscape is displayed in this virtual environment by the derivation of 3D modeling parameters based on various environmental conditions within the virtual ecosystem.

Data Instrument

"The process of continuously observing and regularly measuring environmental parameters of a specific area in order to understand a phenomenon" is the definition of environmental monitoring. Environmental monitoring is crucial for data analysis related to nature and the environment in virtual or augmented reality. [13]

Conclusion

In order to determine the service objectives, design the library virtual reference service system operation objectives, construct the virtual reference service's overall structure, update the online consulting function module's design, and evaluate the impact of this virtual reference consulting service using the quality evaluation index, this paper integrates the user's demand for virtual reference services.

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INTEGRATION OF EMERGING TECHNOLOGIES IN ACADEMIC LIBRARIES: A CASE STUDY OF GOVERNMENT DEGREE COLLEGE (AUTONOMOUS), GAJWEL, TELANGANA

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ABSTRACT
This research paper explores the integration of emerging technologies in academic libraries, focusing on Government Degree College (Autonomous), Gajwel, Siddipet District, Telangana State. Academic libraries are transitioning from traditional repositories of knowledge to technology-enhanced learning hubs that support digital scholarship, efficient information management, and user engagement. The study reviews the key technological trends, evaluates their potential applications at GDC Gajwel, and highlights the challenges and prospects within the Government Degree colleges of the Telangana state.

Keywords: *Emerging Technologies, Degree College libraries, Blogs, Cloud Computing, AI,*

Introduction

Academic libraries are considered as the heart of academic institutions. Nowadays, Academic libraries have undergone substantial transformation due to rapid advancements in information and communication technologies (ICT). Traditional cataloguing and physical collections are no longer enough to meet the evolving needs of students, faculty, and researchers. Emerging technologies such as Artificial Intelligence (AI), digital reference services, discovery systems, and hybrid library models reshape library functions, user interaction, and resource access.

Government Degree College (Autonomous), Gajwel.

Government Degree College (Autonomous) Gajwel was established in 1997 in Gajwel town, Siddipet District, Telangana State. This college is affiliated with Osmania University, Hyderabad, and is recognized by the UGC under sections 2(f) and 12(b) of the UGC Act 1956. The college was accredited with a 'B+' grade in the year 2021 in its 3rd cycle by the National Assessment and Accreditation Council (NAAC), Bangalore. Our college was conferred with UGC Autonomous Status from the academic year 2025-2026 onwards. The college has been offering undergraduate programmes, i.e. B.A., B.Com. and B.Sc., for the rural background students in this region.

Government Degree College (Autonomous), Gajwel Library.

The Library at Government Degree College (A) Gajwel is well equipped with textbooks, reference books, general and competitive books, journals, magazines, newspapers, back volumes of journals, CD/DVDs, syllabus copies, and previous question papers to support the teaching and learning activities of the college. The Library caters to the information needs of more than 600 users, including students, teaching staff, and non-teaching staff of the college. The college library is automated with INFLIBNET's SOUL 3.0 software, and it has initiated an Institutional Digital Repository, in which faculty publications and courseware can be accessed by students and faculty members.

Literature Review

As per the study of Inamdar (2022), emerging technologies and their implications for library services and operations. By embracing emerging technologies while also upholding their core values, libraries can continue to serve their communities and provide a valuable resource for learning, research, and discovery.

According to Vysakh (2020), emerging technologies are used for service delivery in the library. Numerous technologies have emerged recently, and some of these technological facilities are used in the library.

According to Lubanga and Mumba (2021), there are a number of obstacles that prevent libraries from implementing high-end technologies, including a lack of well-established centres for research and innovation, the unpredictable nature of technological advancement in the twenty-first century, and university cultures that discourage research and innovation.

According to Saibakumo (2021), the largest barriers to adopting new technology are a lack of funding, a shortage of power, and inadequate maintenance. Both information costs and quality are increasing. Fiscal restraints, insufficient maintenance and cultural updating, and a problem with record conversion can be linked to infrastructure problems, a lack of informatics/learning, and a lack of government assistance.

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Makori and Mauti (2016) also listed a lack of knowledge, ICT infrastructure, information resources, social computers, weak institutional and physical structures, and a lack of skills and competence as factors that hinder the use of digital technology.

The main obstacles to implementing the newest technology in academic libraries have been identified as inadequate money for the library, a lack of competent library staff or a user education programme on improving library technology, and frequent power outages (Jan and Sheikh, 2014).

Research Objectives

The following is the objective for the present study.

- To identify emerging technologies relevant to College libraries.
- To evaluate the current technological preparedness of GDC (A) Gajwel Library.

Methodology Adopted

This study employs a qualitative review of secondary literature on emerging library technologies and contextualizes their relevance for Government Degree College (A), Gajwel.

Emerging Technologies

The Internet and other emerging technologies have been changing the total atmosphere and services of any library. It has been changing the way people communicate, interact, acquire, share, search, investigate and participate in the creation and reuse of the content and information (Jagdish Arora, 2009). Government Degree College (A), Gajwel Library has been harnessing these technologies to better support academic success, research, and lifelong learning.

Integrated Library Systems (ILS): Integrated Library Systems (ILS): Integrated Library Systems are the foundation of modern library management. Various open source softwares (Koha, NewGenLib, etc.) and commercial library automation software (SOUL, LIBSYS, VTLS, etc.) are available for computerisation of library housekeeping activities.

Government Degree College (Autonomous) Gajwel library has been automated using the SOUL 3.0 software. The housekeeping activities, such as acquisition, circulation, serials control, OPAC and administration activities, have been computerised to provide effective and efficient services to the users.

OPAC/WebOPAC: OPAC stands for Online Public Access Catalogue. OPACs are searchable by Author, Title, Subject and Keywords. Besides the bibliographical information, document availability, location, status, etc., information is displayed in OPAC. WebOPAC is accessible over the intranet and on the web.

The Library in Government Degree College (Autonomous) Gajwel has been providing OPAC/WebOPAC services to the users by establishing dedicated systems in the library for this purpose. Users can access the library catalogue through their mobiles within the campus.

Digital Library: Digital Library is a library in which the resources are available in a digital or machine-readable format. In simple terms, it can be defined as an electronic library with large and diverse repositories of electronic resources. Government Degree College (Autonomous), Gajwel, has taken the initiative towards establishing the Digital Library using the DSpace Digital Library Software. Faculty publications, Student study projects, Syllabus copies, Old question papers, college news clippings, etc., are preserved in this digital repository for the usage by the students and faculty members of the college.

Library Website: A website is a collection of related web pages on the internet. A website is one of the effective marketing tools for the libraries. A library which does not have a website is missing the opportunity "for marketing its services & this usually affects the patrons negatively in terms of finding the information they need." (Burke, J. 2011).

Government Degree College (Autonomous), Gajwel Library is providing access to Online Public Access Catalogue (OPAC), library rules, links to useful websites, promoting access to subscribed as well as Open access Educational resources (OERs), etc.

Library Blog: According to Wikipedia "Blog is a discussion or informational website published on the World Wide Web." Blog can be considered as personal website. WordPress and Blogger.com are the most popular Blogger websites designers.

Government Degree College (Autonomous), Gajwel library has been successfully integrating the blog to promote its resources and services. Through the blog, our library shares the new arrivals, learning materials, old question papers, syllabus, and other Open Access Educational Resources (OERs) with the users. Users also can communicate with the librarian and post their opinions, feedback and suggestions for the library.

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Mobile Technologies: Mobile devices have become a part of our daily lives. They made our life more convenient by providing access to all the useful information at our fingertips. They keep us connected with family, friends, teachers, and colleagues through calls, text messages, e-mail, apps, and other social media networking applications. Mobile technologies can help libraries to reach more users and provide more convenient and accessible services. Mobile technology has come up with "the libraries in hand" trend. Librarians will need to become proficient in using these devices to enable users to access them anywhere from any place. (Rekhraj Sahu, 2016)

Social Media: Social media technologies such as Twitter, Facebook, and Instagram can be powerful tools for libraries to engage with users, promote their services and collections, and provide information and updates in real time. Libraries are not the exception to using the social media to foster online communities and encourage collaboration and knowledge sharing.

Our college library has been providing services, such as career and academic updates, overdue book reminders, new arrivals, library activities, event invitations, and other services to the users.

Barcode Technology: Barcode technology improves the speed and efficiency of library activities by eliminating errors and to reduces the time spent in keying the books and member's data into the library automation software. Government Degree College (Autonomous), Gajwel, is using barcode technology for the circulation of library resources as well as for the stock verification of library resources purpose.

QR Code Technology: A Quick Response (QR) code is an enhancement of barcode technology. Several versions and variations of QR codes are available that can be customized for different purposes, or which can store greater amounts of data.

Our college library has adopted QR code technology for providing services, such as providing the links for easy access to the library website, library blog, library membership registration, access to Open Educational Resources, etc.

Cloud Computing: Cloud computing is a combination of networking, storage technologies, which facilitates libraries in providing valuable services to their users. It uses web technology and central remote servers to maintain data, software and applications. Cloud computing allows users to use applications which have been installed on servers. Cloud computing enables the libraries in storing and managing the data more efficiently. Libraries can use cloud computing technology, such as Google Docs, Google Forms, Google Drive, Google Calendar, etc. (Yan, H. 2013)

Our college library has been using cloud computing technology for various purposes, such as library blog hosting, library event registration, organizing the competitions, such as essay writing, e-quizzes, etc., during the National Librarians Day, National Library Week celebrations, World Book and Copyright Day celebrations.

E-Learning: Libraries have been serving as a vital resource to enhance their formal education through e-learning tools such as SWAYAM, NPTEL, and SWAYAM PRABHA, etc. This platforms offers variety of courses that enables the users in learning new skills and expand their knowledge, that helps in their personal growth or professional advancement.

E-Resources: E-Resources stands for Electronic Resources. Information which can be stored, accessed and transmitted through electronic gadgets is called electronic information resources (Meera, 2002). Academic libraries have been providing access to various electronic resources for their clientele.

Government Degree College (Autonomous), Gajwel library is a member of Central Government's One Nationa One Subscription (ONOS) scheme, which facilitate in providing access to more than 13000 e-journals to its students and faculty members.

Electronic Security Technology: Electronic security systems are modern technological devices that are used with the aid of electrical apparatus to secure library materials. The security of academic libraries in Telangana is a major concern to the librarians because so much funding has been expended on the collections; therefore, there is a need to ensure adequate security of the resources from book theft and mutilations.

Government Degree College (Autonomous), Gajwel library has been provided with video surveillance and closed-circuit television (CCTV) system to monitor and record security, deter crime, and ensure the safety of library resources. CCTV can also be used to identify visitors and users and deter theft and ensure the security of the premises and other facilities.

Artificial intelligence (AI): AI is the buzz word in the present technology age. Libraries are not exception for AI technology. AI is being used by libraries to improve user experiences and automate routine tasks. For example, AI-powered chatbots can help users with basic questions and recommend resources based on their interests and past usage patterns. (Inamdar, 2022).

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Government Degree College (Autonomous), Gajwel library using the AI technology in attending the reference queries of the users, analyzing the usage patterns of library resources, research assistance services, etc.

CONCLUSION

As libraries continue to adopt these technologies, they reinforce their role as dynamic, future-focused institutions, ensuring that their services remain relevant and impactful in a rapidly evolving digital landscape. Implementation of these technologies is likely to improve the reputation of libraries and the concerned institutions. The role of librarians has been changing in the present digital age, from custodians of books to providing virtual services for the users. The modern technologies are very useful to all types of libraries in providing new and innovative services to their users. Adaptation and implementation of emerging technologies is the need of the hour for any type of library.

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TRANSFORMING ACADEMIC LIBRARIES: ASSESSING INFRASTRUCTURE, USER ENGAGEMENT, AND DIGITAL INTEGRATION IN HEALTH SCIENCES INSTITUTIONS OF CHIKKABALLAPUR DISTRICT

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ABSTRACT
This study explores infrastructure, digital integration, and user engagement in health sciences libraries of Chikkaballapur district, Karnataka. Using mixed qualitative methods including interviews with librarians and faculty (n=14), student focus groups (n=14), on-site observations, and institutional document analysis the study investigates library facilities, ICT adoption, digital resource availability, and user satisfaction. Results indicate that basic facilities like reading rooms and reference sections are well-established (available in 70–80% of institutions), while ICT-enabled study areas and digital tools remain limited. Access to e-resources shows variation: e-books and RGUHS HELINET are present in most institutions (≈70%), whereas e-journals and local repositories are less consistently available. User satisfaction is moderate to high, with higher satisfaction in institutes offering stronger ICT and digital services. Analysis of ICT tools shows printers and scanners are commonly available, while projectors and internet-enabled study zones are scarce. Library budgets have gradually increased from ₹4.2 lakh in 2021 to ₹4.9 lakh in 2024 yet remain insufficient for comprehensive modernization. Findings highlight gaps in digital literacy, uneven implementation of ICT policies, and insufficient professional training. Recommendations include expanded investment in digital collections, development of institutional repositories, ICT infrastructure upgrades, librarian training programs, and enhanced user information literacy. Overall, the study underscores the importance of reimagining academic libraries as digitally integrated, user-focused hubs to strengthen research, learning, and professional development in semi-urban health sciences institutions.

Keywords: *Health Sciences Libraries, Digital Integration, User Engagement, Chikkaballapur, ICT*

Introduction

Academic libraries play a pivotal role in health sciences education by providing students, faculty, and researchers with timely access to authoritative information for evidence-based learning, clinical decision-making, and research. In the current era of digital transformation, libraries are expected to move beyond traditional print-based collections and become technology-enabled, user-focused knowledge hubs. The rapid expansion of health sciences education in Karnataka, particularly in semi-urban districts such as Chikkaballapur, has increased the demand for robust library infrastructure and digital resources.

Karnataka hosts 70 medical colleges, over 300 nursing colleges, and 120 allied health institutions, producing a substantial number of healthcare graduates annually (National Medical Commission, 2024). While national and state-level guidelines encourage ICT-enabled libraries, the reality at district-level institutions is often marked by partial digital adoption, limited budgets, and inadequate infrastructure. Many libraries lack full automation, consistent Wi-Fi, and up-to-date digital subscriptions, leading to uneven access to e-resources and reduced user satisfaction.

The integration of digital tools, institutional repositories, and e-resources is essential for supporting modern pedagogical approaches, including blended learning, research-based assignments, and clinical case studies. However, gaps persist in staff training, user literacy, and effective utilization of available resources. Understanding these gaps is crucial for informing targeted interventions to enhance service delivery and improve user experience.

This study, therefore, investigates the current state of library infrastructure, digital resource access, and user satisfaction in multidisciplinary health sciences institutions of Chikkaballapur district. By identifying infrastructure gaps, usage patterns, and user needs, the research aims to propose practical strategies for transforming academic libraries into modern, service-oriented, and technologically integrated knowledge centres that align with institutional curricula and national standards.

Background

Karnataka has emerged as a leading state in India for health sciences education, hosting 70 medical colleges, of which 24 are government-run and 46 are private institutions (Department of Medical Education, Karnataka, 2023–24). In addition, the state accommodates over 300 nursing colleges and 120 allied health institutions, providing a robust base for training

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healthcare professionals. Annually, these institutions produce approximately 10,000 MBBS graduates and over 35,000 nursing, paramedical, and allied health graduates (National Medical Commission, 2024).

The quality of library services in these institutions is crucial for supporting evidence-based learning, research, and professional development. National and state-level policies, including guidelines issued by the National Medical Commission (2024) and Rajiv Gandhi University of Health Sciences (RGUHS, 2022), mandate the establishment of ICT-enabled libraries, subscription to digital databases such as HELINET, and adequate staffing by qualified librarians. According to RGUHS, over 92% of affiliated colleges are expected to maintain ICT-enabled libraries and digital resources.

Despite these provisions, field observations in semi-urban districts like Chikkaballapur indicate uneven adoption of ICT facilities. Only 43% of libraries have consistent internet/Wi-Fi connectivity, while 57% of libraries possess fully equipped computer terminals. Access to digital resources is similarly uneven: while 71% of institutions have e-books and HELINET subscriptions, only 57% provide e-journals, and 43% maintain institutional digital repositories. Budgetary limitations further restrict modernization, with average annual library allocations ranging from ₹4.2 lakh in 2021 to ₹4.9 lakh in 2024.

This context underscores the importance of assessing infrastructure gaps, user needs, and ICT adoption to formulate evidence-based strategies for transforming academic libraries in semi-urban health sciences institutions. The study aims to provide insights that can guide policymakers, administrators, and librarians in improving equitable access to knowledge resources and digital learning tools.

Literature Review

Aithal, P. S. (2019). Digital transformation in higher education. Aithal examines the growing role of ICT in higher education and academic libraries. The book emphasizes the use of e-resources, online databases, and digital learning tools for effective knowledge dissemination. It highlights strategies for managing digital collections and integrating them into teaching-learning processes. Challenges related to infrastructure, user training, and digital literacy are also discussed. The work provides a framework for assessing digital readiness in academic institutions.

Gupta, D. (2018). ICT in academic libraries. Gupta explores the adoption of information and communication technologies across academic libraries in India. The book addresses infrastructure planning, digital repositories, and ICT-enabled services. It also examines barriers such as budget limitations, staff training, and uneven technology uptake. Case studies illustrate successful ICT integration in select institutions. The study underscores the importance of strategic planning for sustainable digital library services.

Johnson, C. (2015). Innovations in library services. Johnson presents global case studies of innovative practices in academic libraries. Emphasis is placed on user-centred design, digital resource integration, and service transformation. The book discusses ways to improve user engagement and learning outcomes through technological adoption. Challenges of aligning innovation with institutional policies are also addressed. The text serves as a guide for implementing creative and practical library solutions.

Patel, R. (2020). Digital learning tools in health sciences education. Patel focuses on the integration of digital tools and e-learning resources in medical and allied health programs. The book highlights student engagement, access to e-journals, and interactive learning platforms. It discusses how digital libraries support research and curriculum delivery. Challenges such as limited ICT infrastructure and faculty training are noted. Practical recommendations for maximizing digital learning benefits are provided.

Smith, J. (2019). Digital repositories in educational institutions. Smith emphasizes the design, management, and accessibility of institutional digital repositories. The book explains metadata standards, digital preservation, and access control mechanisms. It provides guidance on repository adoption to enhance research visibility. Challenges in standardization and interoperability are discussed. The work underscores the importance of repositories in modern academic libraries.

Thomas, A. (2018). ICT integration in medical colleges. Thomas analyses the implementation of ICT in medical and health sciences institutions. The book discusses improvements in library services, student learning, and faculty research outcomes. Barriers such as limited funding, infrastructure, and staff competencies are examined. It provides examples of effective ICT integration in teaching and research support. Recommendations focus on strategic investment and training to enhance ICT adoption.

Yin, R. (2018). Case study research. Yin provides methodologies for conducting rigorous case study research in institutional settings. The book guides qualitative data collection, analysis, and reporting. It highlights triangulation, reliability, and validity considerations. The text is widely used for evaluating organizational practices and program effectiveness. The methodology informs the design and execution of this study in Chikkaballapur.

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Srivastava, R. (2020). Health sciences education in India. Srivastava examines infrastructure, resource access, and institutional challenges in Indian health sciences education. The book explores library services, ICT adoption, and digital resource utilization. It highlights disparities between urban and semi-urban institutions. Recommendations include infrastructure investment, capacity-building, and policy alignment. The work provides contextual insights for evaluating library transformation initiatives.

Objectives

- Assess library infrastructure and availability of ICT tools in health sciences institutes.
- Examine access to digital resources and repositories.
- Measure user satisfaction and engagement among students and faculty.
- Identify gaps in infrastructure, policy implementation, and digital literacy.
- Provide recommendations for service innovation and modernization.

Methodology

Research Design: This study adopts a mixed-methods approach, combining qualitative and descriptive research strategies to comprehensively evaluate academic libraries in health sciences institutions of Chikkaballapur district. The design integrates qualitative insights from interviews and focus groups with quantitative descriptive measures, such as infrastructure availability, digital resource access, and user satisfaction percentages. This approach enables a nuanced understanding of both user experiences and institutional capacities.

Sampling

A purposive sampling strategy was used to select seven institutions that represent the diversity of health sciences education in Chikkaballapur: 1 government medical college, 3 nursing and allied health colleges, and 3 private medical colleges. This selection ensured coverage of different governance types, student populations, and library setups. The sample allows examination of both common trends and institution-specific practices.

The study involved a total of 28 participants, comprising 6 librarians, 8 faculty members, and 14 students. Librarians provided information on library infrastructure, digital tools, and administrative processes. Faculty members shared perspectives on resource adequacy, curriculum support, and teaching integration. Students reported usage patterns, satisfaction levels, and training needs for digital and print resources.

Data Collection: Data were collected using multiple methods to ensure triangulation and reliability:

- Semi-structured interviews with librarians, faculty, and administrators to capture in-depth insights into library services, digital adoption, and perceived gaps.
- Focus group discussions with students to understand collective experiences, preferences, and challenges in accessing library resources.
- Document analysis of library records, subscription lists, budgets, and policy documents to quantify infrastructure and digital adoption.
- On-site observations of ICT facilities, study zones, and library automation systems to assess functional availability and usage.

Table 1: Core Library Facilities Availability (N = 7)

Facility	Fully Equipped	Partially Equipped	Absent	Total	% Fully Equipped
Study Halls	5	2	0	7	71%
Reference Collections	4	3	0	7	57%
Wi-Fi Access	3	3	1	7	43%
Computer Terminals	4	2	1	7	57%

Source: Primary Data, 2025

The table indicates that most libraries in the sampled institutions possess basic facilities, with study halls being the most widely available (71% fully equipped). Reference collections and computer terminals are moderately equipped, with 57% of libraries fully providing these resources. Wi-Fi access is the least consistently available, with only 43% of libraries fully equipped, indicating limited digital connectivity. Overall, while foundational infrastructure exists, gaps in ICT and digital readiness suggest the need for targeted upgrades to support modern academic and research requirements.

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Table 2: Access to Digital Academic Resources (N = 7)

Resource	Institutes with Access	Institutes without Access	Total	% Access
E-Journals	4	3	7	57%
E-Books	5	2	7	71%
RGUHS HELINET	5	2	7	71%
Institutional Repository	3	4	7	43%

Source: Primary Data, 2025

The table shows that access to digital academic resources is uneven across the sampled libraries. E-books and RGUHS HELINET subscriptions are relatively more accessible, available in 71% of the institutions, reflecting partial adoption of digital learning tools. E-journals are accessible in 57% of libraries, indicating moderate availability for research purposes. Institutional repositories are the least available, with only 43% of libraries providing access, highlighting a gap in locally curated digital content. These findings suggest that while some digital resources are integrated, there is significant scope to expand access and standardize e-resource provision across institutions.

Table 3: User Satisfaction with Library Services

Level	Students (n=14) – Number (%)	Faculty (n=8) – Number (%)
High	4 (28%)	3 (35%)
Moderate	7 (52%)	4 (45%)
Low	3 (20%)	1 (20%)

Source: Primary Data, 2025

The table indicates that a minority of students (28%) and faculty (35%) report high satisfaction with library services. The majority of students (52%) and faculty (45%) rate services as moderate, suggesting that libraries partially meet user needs. A smaller portion of users (20%) are dissatisfied, reflecting gaps in infrastructure, digital resources, or training. Overall, the data imply a need to enhance library services, particularly digital access and user support, to improve satisfaction levels.

Table 4: ICT Tools and Study Facilities

Tool/Facility	Available	Not Available	Total	% Available
Scanners	4	3	7	57%
Printers	5	2	7	71%
Projectors	3	4	7	43%
Internet Study Zones	2	5	7	29%

Source: Primary Data, 2025

The table shows that basic ICT tools such as scanners and printers are moderately available, with 57% and 71% of libraries equipped, respectively. Projectors are less common, present in only 43% of institutions, while dedicated internet-enabled study zones are the least available at 29%. This indicates that although libraries provide some essential ICT infrastructure, there is a substantial gap in advanced digital and study facilities, limiting students' and faculty's ability to fully utilize digital learning resources and collaborative study spaces.

Table 5: Annual Library Budget Trends (₹ in Lakhs)

Year	Average Allocation
2021	4.2
2022	4.5
2023	4.7
2024	4.9

Source: Primary Data, 2025

The table shows a gradual increase in average annual library budgets over four years, from ₹4.2 lakhs in 2021 to ₹4.9 lakhs in 2024. This steady rise (approximately 16.7% over four years) indicates growing financial support for library operations. However, given the existing gaps in ICT infrastructure, digital resource subscriptions, and user training, the current allocations may still be insufficient to fully modernize libraries and meet the evolving needs of health sciences students and faculty in Chikkaballapur district.

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Findings

- **Core Infrastructure Adequacy:** Physical facilities like study halls, reference collections, and computer terminals are largely sufficient across the sampled institutions.
- **Uneven ICT and Digital Resources:** Wi-Fi access, e-journals, institutional repositories, and digital learning tools are inconsistently available, creating disparities in resource access.
- **Limited Librarian Training:** Insufficient professional development in e-resource management and ICT integration hampers optimal use of available digital resources.
- **User Satisfaction Linked to Digital Access:** Students and faculty report higher satisfaction in institutions with better ICT support, digital subscriptions, and study zones.
- **Budget Constraints:** Financial limitations restrict expansion of ICT facilities, digital subscriptions, and institutional repositories.
- **Variation in Policy Implementation:** Institutes differ in adopting structured policies and resource management practices, resulting in uneven service quality.
- **Need for Coordinated Strategy:** Findings indicate the importance of addressing infrastructure gaps, staff capacity, digital resource access, and consistent policy application to modernize library services effectively.

Recommendations

- **Enhance Digital Resource Infrastructure:** Institutions should not only expand access to e-journals, e-books, and databases but also develop comprehensive institutional repositories to host theses, research outputs, and learning materials, ensuring long-term accessibility and preservation.
- **Professional Development for Library Staff:** Regular workshops, certification programs, and peer-learning sessions should be organized for librarians, focusing on advanced ICT tools, digital resource management, metadata standards, and user engagement strategies to improve service quality.
- **Upgrade ICT-enabled Learning Spaces:** Libraries should invest in reliable high-speed Wi-Fi, additional computer terminals, projectors, scanners, and collaborative study zones to support modern pedagogical needs and blended learning approaches.
- **Structured User Education Programs:** Semester-wise orientation, credit-based information literacy modules, and targeted training for research methodologies should be implemented to equip students and faculty with skills to effectively navigate, evaluate, and utilize digital resources.
- **Standardize Library Policies:** Institutes must align internal policies with national standards and RGUHS guidelines, ensuring consistent acquisition practices, licensing agreements, access protocols, and evaluation procedures across all health sciences institutions.
- **Collaborative Resource Procurement:** Forming district- or consortium-level agreements for pooled subscription of e-resources can reduce costs, increase bargaining power, and provide equitable access to high-quality digital content for all affiliated institutions.
- **Monitoring and Assessment:** Establish a continuous evaluation framework to track resource usage, user satisfaction, and digital adoption, enabling data-driven decision-making for future infrastructure development and service improvement.
- **Promote Open Access and Knowledge Sharing:** Encourage use of open-access platforms, institutional repositories, and inter-library loan mechanisms to maximize resource availability while minimizing cost constraints.

Conclusion

The study of health sciences libraries in Chikkaballapur district highlights the critical role of academic libraries in supporting education, research, and clinical practice. Findings indicate that while core physical infrastructure such as study halls, reference collections, and computer terminals is largely adequate, ICT facilities and access to digital resources remain unevenly distributed across institutions. User satisfaction is closely linked to the availability of digital tools, Wi-Fi connectivity, and structured training programs, emphasizing the importance of technology-enabled learning spaces. Budgetary constraints, limited librarian training, and inconsistent policy implementation continue to impede library modernization, restricting the full utilization of e-resources and ICT facilities.

The study underscores the necessity of a multi-pronged approach to transform library services: upgrading digital infrastructure, enhancing professional competencies of library staff, implementing structured information literacy programs,

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and harmonizing policies with national and RGUHS guidelines. Collaborative initiatives such as consortium-based e-resource procurement and shared institutional repositories can improve access while optimizing costs. Continuous monitoring, assessment, and user-centred planning are essential for ensuring that library services evolve in line with institutional curricula and emerging pedagogical practices.

Overall, modernized and digitally integrated library services in Chikkaballapur's health sciences institutes can significantly enhance teaching, learning, and research outcomes. By addressing infrastructure gaps, professional development, and policy alignment, libraries can transform from passive repositories into proactive, innovative knowledge hubs that foster academic excellence, equitable access, and sustainable development in health sciences education.

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ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) IN AGRICULTURE: POLICY IMPLICATIONS FOR INDIA

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ABSTRACT

Agriculture remains a cornerstone of the Indian economy, contributing nearly 17 percent to the national Gross Domestic Product (GDP) and providing livelihoods to more than 60 percent of the population. Despite its economic and social significance, the sector continues to face persistent challenges such as fragmented markets, inadequate access to timely and reliable information, small and marginal landholdings, and low adoption of modern agricultural technologies. In this context, Information and Communication Technology (ICT) has emerged as a transformative tool for improving agricultural productivity, sustainability, and farmers' incomes. ICT-enabled platforms facilitate timely dissemination of localized, personalized, and actionable information related to weather, crop management, pest and disease control, input availability, and market prices. This paper reviews the role of ICT in Indian agriculture, examines major ICT initiatives, analyzes the prevailing frameworks for information dissemination, and proposes an advanced ICT framework incorporating emerging technologies such as big data analytics, artificial intelligence, remote sensing, and decision-support systems. The study highlights key policy implications for strengthening digital agriculture in India.

Keywords: *ICT, Agriculture, Digital agriculture, Information dissemination, India, Farmers*

Introduction

Agriculture plays a vital role in India's socio-economic development, accounting for approximately 17 percent of GDP and employing over two-thirds of the rural population. The growing demand for food grains, coupled with climate variability and resource constraints, necessitates substantial improvements in agricultural productivity and efficiency. However, Indian agriculture is constrained by structural and systemic issues including poor market integration, delayed and unreliable information flows, small landholdings, limited extension services, and uneven adoption of improved technologies.

The rapid advancement of information and communication technologies has opened new avenues for addressing these challenges. ICT has the potential to modernize traditional agricultural practices by enabling faster communication, real-time decision-making, and enhanced access to knowledge and markets. Empowering farmers with the right information at the right time is particularly critical for small and marginal farmers, who are most vulnerable to production and market risks. Consequently, ICT-based agricultural services—often referred to as e-agriculture—have gained prominence as an essential component of agricultural development strategies.

Concept and Importance of ICT in Agriculture

Information and communication have always been integral to agriculture. Historically, farmers relied on interpersonal communication and indigenous knowledge systems to make farming decisions. ICT extends this process by using electronic means to collect, store, process, and disseminate information efficiently and at scale. ICT in agriculture encompasses tools such as mobile phones, web portals, mobile applications, SMS and voice-based advisories, information kiosks, video-based learning, and satellite-based technologies.

The integration of ICT in agriculture facilitates precision farming, improves resource-use efficiency, reduces information asymmetry, and strengthens farmers' capacity to respond to climatic and market uncertainties. By enabling two-way communication between farmers and experts, ICT also enhances the effectiveness of agricultural extension systems.

Role of ICT in Agricultural Development

ICT as a Decision Support System

One of the most significant contributions of ICT in agriculture is its role as a decision support system. ICT platforms provide farmers with real-time and location-specific information on weather forecasts, crop varieties, nutrient management, pest and disease outbreaks, and recommended agricultural practices. Such information enables farmers to plan cropping patterns, optimize input use, and improve productivity and quality.

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The dissemination of tailored technologies suited to specific agro-climatic zones, soil types, and farm sizes remains a major policy challenge in India. ICT-based advisory services help bridge this gap by offering personalized solutions, often through question-and-answer services, which have been widely perceived as highly effective by farmers.

Expanding Market Access
Limited market information and long marketing chains significantly reduce farmers' share in consumer prices. ICT platforms enable farmers to access real-time market prices, identify suitable markets, and connect directly with buyers, thereby reducing dependence on intermediaries. Improved market transparency empowers farmers to make informed decisions regarding crop selection, timing of sales, and choice of marketing channels, ultimately enhancing farm incomes.

Strengthening and Empowering Farming Communities
ICT facilitates networking and collaboration among farmers, research institutions, government agencies, non-governmental organizations, and private sector stakeholders. Exposure to scientific knowledge, peer learning, and success stories strengthens farmers' capacities and fosters collective action. Digital platforms also support farmer producer organizations (FPOs) by improving coordination, aggregation, and market linkages.

Major ICT Initiatives in Indian Agriculture

India hosts one of the largest numbers of ICT initiatives in agriculture globally. However, their distribution has been uneven, with greater concentration in socio-economically advanced regions. Some notable initiatives include:

- AGRISNET: A government-funded portal providing information on inputs, soil health, government schemes, and improved technologies.
- Digital Green: A participatory video-based extension model that promotes peer-to-peer learning among farmers.
- eSagu: A personalized advisory system delivering expert recommendations based on farm-specific data and images.
- Warana Wired Village Project: An early initiative offering localized agricultural and government information through village kiosks.
- IFFCO Kisan Sanchar Limited (IKSL): A mobile-based advisory service delivering voice messages and expert interactions.
- AGMARKNET: A nationwide agricultural marketing information system providing price and arrival data.
- mKisan Portal: An SMS-based platform delivering advisories and services in local languages.
- Kisan Call Centers (KCCs): Toll-free helplines providing expert advice in regional languages.
- Village Knowledge Centers (VKCs): Community-based information hubs established by MS Swaminathan Research Foundation.

These initiatives demonstrate the diverse applications of ICT across production, marketing, fisheries, and dairy sectors.

ICT Components and Tools Used in Agriculture

The primary ICT components used in Indian agriculture include web portals, mobile applications, SMS and voice services, information kiosks, video-based learning modules, and expert video conferencing. Among these, mobile phones have emerged as the most accessible and widely used tool for agricultural communication, particularly for market-related information.

Empirical studies indicate that farmers using ICT-based information systems make significantly better production and marketing decisions and incur lower transaction costs compared to non-users. ICT-based livestock and crop advisory services have also contributed to improved farm management practices across several Indian states.

Framework of ICT in Agriculture

Existing ICT initiatives in India primarily focus on information dissemination, often mediated by field coordinators who act as intermediaries between farmers and experts. This model is necessary due to varying levels of digital literacy and access among farmers. While effective, the current framework remains limited in its integration of advanced technologies and data-driven decision-making.

Proposed Advanced ICT Framework

The proposed framework extends beyond agricultural advisories to include education, health, e-governance, and employment information for rural communities. It emphasizes the integration of advanced technologies such as:

- Big Data Analytics: For predictive insights on weather, markets, and crop performance.

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- Artificial Intelligence and Cognitive Computing: For crop selection, yield forecasting, and risk assessment.
- Remote Sensing, GIS, and GPS: For precision agriculture, land-use mapping, and resource monitoring.
- Image Processing: For early detection of pests, diseases, and nutrient deficiencies.
- Simulation and Modelling: For mechanization planning and climate adaptation strategies.

Incorporating trust, data security, and infrastructure development into technology acceptance models is essential for wider adoption.

Conclusion and Policy Implications

ICT has immense potential to transform Indian agriculture by improving access to information, enhancing productivity, reducing risks, and increasing farmers' incomes. However, despite numerous initiatives, ICT has yet to achieve a decisive breakthrough at scale. Greater emphasis is needed on systematic evaluation, inclusivity, infrastructure development, and integration of advanced digital technologies.

Policy Recommendations

- Rigorous evaluation of existing ICT initiatives based on feedback from grassroots extension workers and farmers.
- Transition towards comprehensive digital agriculture systems.
- Enhancing digital literacy and access among small and marginal farmers.
- Promoting adoption of advanced ICT tools such as AI, GIS, remote sensing, and IoT.
- Strengthening big data governance and analytics for evidence-based agricultural policymaking.

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DIGITAL TRANSFORMATION BEYOND TECHNOLOGY: EMBEDDING SUSTAINABILITY AND INCLUSIVITY IN ACADEMIC ECOSYSTEMS

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ABSTRACT
Digital transformation in higher education has largely been interpreted as the adoption of digital tools, online platforms, and advanced information systems. However, such a technology-centric approach often overlooks the broader objectives of sustainability and inclusivity. This paper argues that digital transformation must transcend mere technological integration and evolve into a holistic academic ecosystem that is environmentally sustainable, socially inclusive, and pedagogically equitable. By examining the dimensions of sustainable digital practices, inclusive access for diverse learners, and institutional responsibilities, the study highlights how higher education institutions can align digital transformation with long-term societal goals. The paper adopts a conceptual and analytical approach, drawing insights from policy frameworks, institutional practices, and emerging trends. It concludes by proposing a strategic framework for embedding sustainability and inclusivity into digital academic ecosystems, ensuring that digital transformation contributes meaningfully to equitable and responsible higher education.

Keywords: *Digital Transformation, Sustainability, Inclusivity, Higher Education, Academic Ecosystems, Digital Equity*

Introduction

The rapid digitalization of higher education has transformed the way teaching, learning, research, and administration are conducted. The proliferation of learning management systems, digital libraries, online assessments, and virtual classrooms has redefined academic engagement. While these advancements have enhanced efficiency and accessibility, digital transformation is frequently perceived as a technological upgrade rather than a systemic change.

This narrow perception raises critical concerns. Digital expansion without sustainability may intensify environmental costs through increased energy consumption, electronic waste, and resource-intensive infrastructure. Similarly, digital initiatives lacking inclusivity risk widening the digital divide, marginalizing students from disadvantaged socio-economic backgrounds and learners with disabilities. Therefore, digital transformation must be reimagined as a comprehensive process that embeds sustainability and inclusivity into the academic ecosystem.

This paper explores how higher education institutions can move beyond technology-driven transformation to create academic ecosystems that are digitally advanced, environmentally responsible, and socially inclusive.

Conceptualizing Digital Transformation in Academic Ecosystems

Digital transformation in higher education refers not only to the use of digital tools but also to the reconfiguration of institutional processes, pedagogical models, and governance structures. An academic ecosystem comprises interconnected elements such as students, faculty, administrators, infrastructure, policies, and external stakeholders.

A transformed academic ecosystem emphasizes:

- Learner-centered digital pedagogy
- Institutional adaptability and resilience
- Ethical and responsible use of technology
- Alignment with social and environmental goals

Thus, digital transformation becomes a strategic and cultural shift rather than a purely technical intervention.

Sustainability in Digital Transformation

Environmental Sustainability

Digitalization has the potential to reduce paper consumption, physical commuting, and resource-intensive administrative processes. However, it also introduces challenges such as increased electricity usage, data center emissions, and electronic waste.

Sustainable digital transformation requires:

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- Energy-efficient IT infrastructure
- Cloud computing with green energy sources
- Responsible e-waste management
- Promotion of digital minimalism and resource optimization
- By adopting green IT policies, institutions can minimize the ecological footprint of digital education.

Economic Sustainability

Sustainable digital transformation ensures long-term financial viability. Investments in open-source platforms, scalable technologies, and shared digital resources reduce operational costs. Additionally, digital repositories and open educational resources promote cost-effective knowledge dissemination.

Institutional Sustainability

Institutions that embed sustainability into digital planning are better equipped to adapt to disruptions such as pandemics, demographic shifts, and funding constraints. Sustainable digital ecosystems enhance institutional resilience and continuity.

Inclusivity in Digital Academic Ecosystems

Bridging the Digital Divide

Despite increased digital access, disparities persist in terms of internet connectivity, device availability, and digital literacy. Students from rural areas, economically weaker sections, and first-generation learners often face structural barriers.

Inclusive digital transformation involves:

- Affordable and accessible digital infrastructure
- Digital literacy training for students and faculty
- Institutional support mechanisms such as device lending and connectivity assistance

Inclusive Access for Differently-Abled Learners

Digital platforms must be designed to accommodate learners with visual, auditory, cognitive, and mobility impairments. Accessibility is not an optional feature but a fundamental requirement of inclusive education.

Key inclusive practices include:

- Assistive technologies such as screen readers and speech-to-text tools
- Universal Design for Learning (UDL) principles
- Captioning, alternative text, and accessible content formats
- An inclusive academic ecosystem ensures equal participation and learning outcomes for all students.

Gender and Social Inclusion

Digital spaces can empower marginalized groups by enabling flexible learning, anonymity, and wider participation. However, without inclusive policies, digital platforms may reproduce existing social inequalities. Gender-sensitive and culturally responsive digital strategies are essential.

Role of Higher Education Institutions

Higher education institutions play a pivotal role in shaping sustainable and inclusive digital ecosystems. Their responsibilities include:

Developing inclusive digital policies

- Integrating sustainability goals into institutional strategies
- Training faculty in inclusive and sustainable digital pedagogy
- Monitoring digital equity and environmental impact
- Leadership commitment and institutional governance are critical for translating digital vision into practice.

Policy Alignment and Strategic Framework

Digital transformation aligned with sustainability and inclusivity supports broader national and global objectives such as quality education, reduced inequalities, and responsible consumption. Institutions must align their digital strategies with policy frameworks and societal expectations.

Proposed Strategic Framework

- Vision Integration: Embed sustainability and inclusivity into digital mission statements

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- Infrastructure Planning: Adopt green and accessible digital technologies
- Capacity Building: Train stakeholders in sustainable and inclusive digital practices
- Monitoring and Evaluation: Measure environmental impact and inclusivity outcomes
- Continuous Improvement: Adapt digital strategies based on feedback and innovation

Challenges and Future Directions

Despite its benefits, embedding sustainability and inclusivity faces challenges such as financial constraints, resistance to change, lack of awareness, and technological complexity. Future research should focus on empirical studies, institutional case analyses, and impact assessments to strengthen evidence-based digital transformation strategies.

Emerging technologies such as artificial intelligence, learning analytics, and immersive learning environments must be deployed responsibly to ensure ethical, inclusive, and sustainable outcomes.

Conclusion

Digital transformation in higher education must evolve beyond the adoption of advanced technologies to encompass sustainability and inclusivity as core principles. A holistic academic ecosystem integrates environmental responsibility, social equity, and digital innovation to create meaningful educational impact. By embedding sustainability and inclusivity into digital strategies, higher education institutions can ensure that digital transformation contributes not only to institutional efficiency but also to long-term societal well-being.

Digital transformation in higher education has reached a critical juncture where its success can no longer be measured solely by technological adoption or digital infrastructure expansion. As this study has emphasized, meaningful digital transformation must transcend tools and platforms to become an integral part of a sustainable and inclusive academic ecosystem. When sustainability and inclusivity are embedded as foundational principles, digital transformation evolves into a catalyst for long-term institutional resilience, social equity, and responsible innovation.

Sustainability in digital transformation extends beyond environmental considerations to encompass economic viability and institutional continuity. Environmentally responsible digital practices reduce the ecological footprint of academic operations, while economically sustainable digital strategies ensure efficient utilization of resources and long-term affordability. Institutions that strategically align digital initiatives with sustainability goals are better positioned to adapt to global disruptions, policy shifts, and changing learner expectations.

Equally important is the role of inclusivity in shaping equitable digital academic ecosystems. Without deliberate inclusion strategies, digital transformation risks reinforcing existing inequalities related to socio-economic status, geography, gender, and disability. Inclusive digital frameworks—supported by accessible technologies, universal design principles, and targeted capacity-building initiatives—ensure that all learners can meaningfully participate in digital education. In this context, inclusivity is not merely a support mechanism but a core determinant of educational quality and justice.

Higher education institutions serve as critical agents in operationalizing sustainable and inclusive digital transformation. Institutional leadership, governance structures, and policy alignment play decisive roles in translating digital vision into practice. Faculty development, student support systems, and continuous monitoring of digital equity and environmental impact are essential for sustaining transformation outcomes. Moreover, collaborative engagement with policymakers, industry partners, and civil society can further strengthen digital academic ecosystems.

Looking ahead, emerging technologies such as artificial intelligence, learning analytics, and immersive learning environments offer unprecedented opportunities to enhance educational access and efficiency. However, their integration must be guided by ethical frameworks, sustainability benchmarks, and inclusivity standards to prevent unintended social and environmental consequences. Future research should focus on empirical evaluations, longitudinal studies, and comparative analyses to generate evidence-based models for sustainable and inclusive digital transformation.

In conclusion, digital transformation beyond technology represents a paradigm shift in higher education—one that places sustainability, inclusivity, and human-centered values at the core of academic ecosystems. By adopting a holistic and responsible approach, higher education institutions can ensure that digital transformation contributes not only to institutional advancement but also to broader societal development, equity, and environmental stewardship.

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DIGITAL LIBRARIES IN THE LIFE SCIENCES: FROM STATIC ARCHIVES TO INTELLIGENT KNOWLEDGE ECOSYSTEMS

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ABSTRACT
The exponential growth of biological data—ranging from high-throughput sequencing to clinical electronic health records—has necessitated a paradigm shift in how scientific knowledge is managed. Digital libraries in the life sciences have evolved from passive repositories of digitized text into dynamic, interconnected ecosystems that integrate scholarly literature with primary experimental datasets. This paper explores the critical role of digital libraries as essential research infrastructure, examining their core functions in data curation, semantic interoperability, and workflow support. By analyzing applications across genomics, clinical research, and public health, the study highlights how these platforms democratize knowledge and enhance research reproducibility. Despite challenges such as data privacy, technical silos, and information overload, the integration of Artificial Intelligence (AI) and cloud-native architectures promises a future where digital libraries act as active, intelligent partners in the scientific discovery process

Keywords: *Digital Libraries, Life Sciences, Bioinformatics, FAIR Data Principles, Open ScienceGenomics, Artificial Intelligence, Knowledge Graphs*

Introduction

Digital libraries have emerged as central platforms for managing scholarly content, datasets, and domain-specific knowledge in the life sciences. Unlike traditional libraries, which rely on physical collections, digital libraries provide seamless online access to a vast array of books, journal articles, research protocols, and multimedia resources. This digital transformation aligns with the urgent needs of a rapidly expanding life-science community that depends on high-throughput data analysis, open science practices, and global, cross-disciplinary collaboration. In the modern biological landscape, the volume and complexity of information have grown exponentially. This "data deluge" is driven by significant technological leaps in high-resolution imaging, proteomics, electronic health records (EHRs), and next-generation sequencing.

As a result, traditional methods of manual organization are no longer sufficient. Effective information retrieval, automated curation, and rapid dissemination mechanisms have become essential infrastructure rather than luxury tools. Digital libraries now support these critical functions by integrating semantic search capabilities and machine-learning algorithms to bridge the gap between raw data and actionable knowledge. Furthermore, they facilitate a shift in scientific culture, enabling new modes of communication through preprint repositories, interactive metadata standards, and integrative databases. These platforms serve as the backbone for reproducible research, ensuring that the global scientific community can access, verify, and build upon findings in real-time.

Evolution of Digital Libraries in Life Sciences

Digital libraries began as straightforward digital mirrors of physical archives, focusing on digitized scholarly articles and basic keyword search interfaces. Early initiatives like PubMed and MEDLINE revolutionized the field by providing centralized, searchable access to millions of biomedical citations, while JSTOR preserved the historical record of biological thought. However, as the "central dogma" of biology moved into the high-throughput era, these libraries had to evolve from simple bibliographic databases into complex, interconnected data hubs. Modern digital libraries now incorporate sophisticated metadata, semantic search, and direct links to primary research datasets. Major institutional pillars such as the National Center for Biotechnology Information (NCBI) and the European Bioinformatics Institute (EMBL-EBI) have moved beyond text, hosting petabytes of genomic, proteomic, and chemical data. This evolution is characterized by a shift from "reading about science" to "computing on science."

The evolution can be traced through several transformative milestones:

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- 1990s: The Digitization Era The focus was on the transition from print to screen. The growth of abstracting and indexing services allowed researchers to move away from physical stacks, though data remained siloed and largely inaccessible for automated analysis.
- 2000s: The Open Access & Interconnectivity Movement The rise of open-access publishing (e.g., PLOS, BioMed Central) challenged traditional paywalls. The integration of Digital Object Identifiers (DOIs) and CrossRef protocols allowed for persistent linking, creating a "web of knowledge" where citations became clickable pathways.
- 2010s: The Big Data & Integrative Era The explosion of Next-Generation Sequencing (NGS) forced libraries to integrate raw datasets, analysis workflows, and computational tools directly into their interfaces. Libraries became workbenches where data and literature co-existed.
- 2020s: The Intelligent & FAIR Era We are currently witnessing the emergence of AI-assisted discovery tools and semantic knowledge graphs that can "understand" the relationship between a gene, a disease, and a drug. The adoption of FAIR (Findable, Accessible, Interoperable, and Reusable) data principles ensures that library content is machine-readable, allowing AI agents to synthesize information across disparate global repositories to accelerate drug discovery and clinical breakthroughs.

Core Functions of Digital Libraries in Life Sciences

Access to Scientific Literature

Digital libraries act as the primary gateway to fragmented biomedical knowledge, aggregating journals, protocols, and reports into a unified entry point.

- Precision Retrieval: Employs Boolean logic and MeSH indexing for granular searches, such as filtering by molecular pathways or clinical trial phases.
- Intelligent Curation: Systems use algorithms to provide Selective Dissemination of Information (SDI), pushing personalized alerts based on research history.
- Open Science: Repositories facilitate equitable access to critical pathogen or clinical data, which is essential for global public health policy.

Data Integration and Curation

Digital libraries transform raw data into usable knowledge through active curation and contextual linking.

- Repository Integration: They link literature directly to primary data in GenBank (sequences) or PDB (structures), closing the "publication gap."
- Standardization: Enforcing metadata standards (e.g., MIAME) and ontologies (e.g., Gene Ontology) ensures machine-readability and semantic interoperability.
- Curation Lifecycle: Continuous appraisal, cleansing, and preservation ensure data remains functional as technology evolves.

Supporting Research Workflows

Libraries have evolved from archives into interactive workbenches that reduce software "friction."

- Bidirectional Linking: Researchers can jump from a protein description in a paper directly to its raw reads in the Sequence Read Archive (SRA).
- Computational Access: APIs enable the automated download of datasets for meta-analysis and the training of biomedical AI models.
- Visual Analytics: Integrated Genome Browsers and interaction network tools allow for the immediate interpretation of complex systems.

Collaboration and Knowledge Sharing

These platforms serve as the "social glue" for global team science.

- Shared Insight: Tools for social bookmarking and shared annotations turn static PDFs into living collaborative documents.
- Rapid Dissemination: Preprint servers like bioRxiv bypass long review cycles, providing immediate community validation during health crises.
- Virtual Environments: Project "sandboxes" allow dispersed teams to synchronize data and maintain a clear provenance trail.

Education and Training

Digital libraries function as virtual mentors for students and clinicians.

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- Interactive Learning: Structured paths provide 3D molecular models and video protocols to bridge theory and lab execution.
- Living References: Textbooks are hyper-linked to real-time clinical databases like ClinVar for the latest mutation insights.
- Professional Development: For clinicians, libraries provide a constant stream of Evidence-Based Medicine (EBM) updates to ensure they remain at the cutting edge of personalized therapy.

Applications in Life Science Domains

Genomics and Bioinformatics

Digital libraries have transitioned from passive storage into sophisticated computational environments where genomic and proteomic data are harmonized to reveal biological blueprints.

- Sequence Repositories: Platforms like GenBank integrate high-performance tools such as BLAST, enabling researchers to identify evolutionary similarities across organisms in seconds.
- Functional Annotation: Systems like Ensembl and RefSeq link raw DNA to protein structures in the PDB and metabolic pathways in KEGG, allowing for seamless functional mapping.
- Big Data Support: Library infrastructures provide the backend for population-scale Next-Generation Sequencing (NGS), ensuring results adhere to FAIR principles for global reuse.

Clinical Research and Evidence Synthesis

Digital libraries act as essential filters that synthesize overwhelming amounts of primary research into actionable medical evidence.

- Trial Transparency: Registries like ClinicalTrials.gov provide access to ongoing studies, helping combat publication bias and preventing research duplication.
- Evidence-Based Medicine (EBM): Specialized hubs like the Cochrane Library provide "pre-appraised" evidence, allowing practitioners to find "Gold Standard" treatment protocols rapidly.
- Translational Integration: By linking clinical trial results with molecular targets, these platforms bridge the "bench-to-bedside" gap, providing a holistic view of the drug development chain.

Public Health and Epidemiology

During health emergencies, digital libraries serve as real-time hubs for "digital epidemiology," where speed is the primary factor in effective response.

- Genomic Surveillance: Platforms like GISAID allow for the instantaneous sharing of pathogen genomes to track mutations and accelerate vaccine design.
- Rapid Review: Preprint servers (bioRxiv, medRxiv) ensure that critical data on transmission or drug efficacy reaches the community immediately, bypassing lengthy publication delays.
- Situational Awareness: Interactive dashboards link geospatial case counts directly to peer-reviewed reports, helping officials visualize hotspots and combat the "infodemic" of misinformation with verified science.

Benefits and Impact

Democratization of Knowledge

Digital libraries act as powerful equalizers by dismantling the traditional geographical and financial barriers to elite scientific information. In the life sciences, where critical breakthroughs often occur in well-funded urban centers, digital platforms ensure that a rural healthcare provider or a researcher in a developing nation has the same equitable access to high-impact journals and clinical guidelines. By hosting open-access content and providing "low-bandwidth" versions of databases, these libraries empower a global community of scholars to participate in the scientific discourse regardless of their institutional affiliation or socioeconomic status.

Research Efficiency

The transition from manual archive searching to AI-driven discovery has radically increased the "clock speed" of scientific progress. Sophisticated search tools—utilizing Natural Language Processing (NLP) and semantic tagging—allow researchers to bypass information overload and pinpoint specific data points (such as a rare gene mutation or a specific drug-protein interaction) in seconds. Furthermore, by providing 24/7 simultaneous access to millions of users, digital libraries eliminate the "wait times" associated with physical collections, allowing researchers to move seamlessly from hypothesis to experimental design.

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Enhanced Reproducibility and Data Integrity

In an era where "reproducibility crises" have challenged scientific credibility, digital repositories provide the necessary infrastructure for transparency. By mandating the submission of raw datasets, software code, and detailed protocols alongside published papers, libraries enable independent verification of results.

- Provenance Tracking: Digital Object Identifiers (DOIs) and version-control systems ensure that the "chain of custody" for data is preserved, allowing scientists to see exactly how a dataset has evolved over time.
- FAIR Standards: By enforcing Findable, Accessible, Interoperable, and Reusable principles, digital libraries ensure that research outputs remain functional and readable for future generations, preventing the "digital decay" of vital biological records.

Supporting Innovation and Collaboration

By serving as a unified "interdisciplinary workbench," digital libraries foster innovation at the intersection of diverse fields. A bioengineer can easily access materials science journals, or a computational biologist can link ecological datasets with genomic trends.

- Knowledge Synthesis: Through tools like knowledge graphs, libraries reveal "hidden" connections between disparate studies, often leading to novel drug repurposing or new insights into complex diseases.
- Community-Driven Discovery: Features such as shared annotations, collaborative project spaces, and integrated social-networking tools transform the library from a silent reading room into a dynamic ecosystem where "Team Science" thrives across borders and disciplines.

Challenges and Limitations

Information Overload and "Cognitive Fatigue"

The sheer volume of life-science publications—now exceeding millions of papers annually—has created a "data deluge" that can overwhelm even the most seasoned researchers. Without sophisticated ranking and filtering systems, users often suffer from cognitive fatigue, spending more time sorting through search results than performing actual analysis.

- The "Signal-to-Noise" Problem: Traditional keyword searches frequently return thousands of irrelevant hits. To combat this, digital libraries are increasingly integrating AI-driven "Guardians"—Large Language Models (LLMs) and recommendation engines—that synthesize abstracts and prioritize content based on a researcher's specific context and history.

Interoperability Barriers and Technical Silos

Data integration remains one of the most significant hurdles in the life sciences. Disparate data formats, proprietary software, and conflicting ontologies make it difficult to link a clinical finding in one database to a genomic sequence in another.

- The Push for Universal Standards: To achieve true interoperability, libraries must adopt standardized protocols like HL7 FHIR for health records or BioCompute Objects for analysis workflows. Breaking down these "data silos" is essential for the future of Precision Medicine, where cross-domain data integration is the only way to tailor treatments to individual genetic profiles.

Data Privacy and Ethical Constraints

As digital libraries host increasingly sensitive patient data, protecting privacy while enabling scientific access has become a high-stakes balancing act.

- Regulatory Compliance: Systems must be strictly designed to comply with evolving regulations such as GDPR in Europe and HIPAA in the United States.
- The Re-identification Risk: With the advent of AI, even "anonymized" genomic data can sometimes be traced back to individuals. This has led to the development of Federated Learning and Blockchain-based consent models, which allow researchers to "query" sensitive data without ever seeing the raw, identifiable information itself.

Sustainability and Long-Term Funding

Digital libraries are not one-time builds; they are living infrastructures that require continuous investment for curation, software updates, and secure cloud storage.

- The "Funding Cliff": Many vital databases are supported by short-term grants rather than permanent institutional budgets. If funding is cut, years of curated data can become "orphaned" and eventually unreadable as technology evolves.
- Environmental Impact: The carbon footprint of the massive data centers required to house life-science "Big Data" is a growing concern. Future library models must address financial and ecological sustainability to ensure that the scientific record remains accessible for decades to come.

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Future Directions

Artificial Intelligence and Semantic Search

By 2030, digital libraries will transition from simple search bars to conversational agents capable of deep reasoning.

- Automated Annotation: AI will programmatically "read" literature to extract gene-disease associations, populating databases without manual intervention.
- RAG Systems: Utilizing Retrieval-Augmented Generation, libraries will provide direct, evidence-based answers with cited sources rather than mere lists of links.

Linked Open Data and Knowledge Graphs

The shift from isolated "data lakes" to interconnected Knowledge Graphs will allow researchers to discover hidden relationships across biological entities.

- Multi-Dimensional Queries: Researchers can simultaneously query drugs, protein targets, and clinical trials in a single step.
- Global Interoperability: Standardized frameworks like RDF will ensure seamless data linking between international laboratory repositories.

Customization and Visualization

The future interface will be a "Discovery Dashboard" tailored to specific research needs.

- Immersive Analysis: Integration of AR/VR will enable scientists to "walk through" 3D protein models or navigate global epidemiological maps.
- Live Bibliographies: Machine learning will automatically update project spaces with preprints and datasets relevant to a researcher's active lab work.

Cloud and High-Performance Computing (HPC)

Digital libraries are moving toward Cloud-Native architectures, rendering the "download" button obsolete.

- In-Situ Analysis: Researchers will bring their code to the data, utilizing integrated HPC clusters for complex simulations directly within the library ecosystem.
- Elastic Scalability: Cloud infrastructures will provide the computational power necessary to handle massive data "spikes" during future global health emergencies.

Conclusion

Digital libraries in the life sciences have evolved from simple digital archives into intelligent, interconnected ecosystems that serve as the backbone of modern discovery. By integrating vast biological datasets with peer-reviewed literature, these platforms effectively bridge the gap between raw data and actionable knowledge. They facilitate Open Science, democratization of information, and research reproducibility on a global scale. While challenges such as information overload, data privacy, and long-term funding persist, the future of these infrastructures lies in AI-driven synthesis and cloud-native analysis. As these systems transition into active research partners, they will remain essential for accelerating breakthroughs in genomics, clinical research, and public health, ultimately driving the next generation of life-saving innovations.

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ARTIFICIAL INTELLIGENCE (AI) TOOLS IN SOCIAL SCIENCE RESEARCH: THE PROSPECTS AND PROBLEMS

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ABSTRACT
With the rapid advancement of Artificial Intelligence (AI), its tools have emerged that support researchers in improving accuracy, efficiency, and relevant literature review. AI has emerged as a transformative force in social sciences research, reshaping traditional research practices and enhancing scholarly productivity. The increasing complexity of social data, growing volume of scholarly literature, and demand for timely research outputs have made AI tools indispensable for researchers. AI-supported tools assist at every stage of the research process, including literature search, review of related literature, research design, data collection, data analysis, academic writing, citation management, and research ethics. This paper examines the usefulness of AI tools in social sciences research, such as ChatGPT, Google Scholar, Scite, Copilot, SciSpace, Elicit, ResearchRabbit and SPSS, Grammarly, reference management tools, and plagiarism detection system.

Keywords: *ICT, AI Tools, Social Sciences Research, Literature Review, Data Collection, Data Analysis.*

Introduction

Today, Information Technology (IT) or Information Communication Technologies (ICT) and software technologies, especially, Artificial Intelligences (AI) are playing a pivotal role for the development of a nation. Without quality of research, it's not possible. So, modern AI technologies are playing a crucial role in research by enhancing efficiency, accuracy, and collaboration. ICT provides to researchers with easy access to digital libraries, online databases, e-journals, and research networks, enabling faster literature search, data collection and analysis including research reporting.

AI supports research activities by assisting in literature review, data analysis and academic writing. Together, ICT and AI streamline the research process, reduce time and cost. AI research tools are software applications that use Artificial Intelligence techniques—such as Machine Learning (ML), Natural Language Processing (NLP), Deep Learning to support, automate, and enhance various stages of the research process.

AI tools are now widely used by researchers for searching scholarly literature, organizing references, analyzing qualitative and quantitative data, and preparing research outputs. In social sciences—where both qualitative and quantitative approaches dominate—AI provides methodological support without replacing the intellectual role of the researcher. This paper explores the usefulness of very important AI tools in social sciences research and their contribution to improving research quality and productivity.

Meaning and Definitions of AI Research Tools:

Meaning: AI research tools are intelligent digital tools that help researchers do research faster, better, and more accurately.

Definitions: The followings are some of the definitions on AI Tools discussed. They are:

- **AI research tools** are used; to assist different academic disciplines research scholars, especially social sciences-in discovering, analyzing, organizing, and synthesizing scholarly information.
- **AI research tools** refer to computer-based applications that automate or augment research activities such as literature review, data interpretation, hypothesis formulation, and report writing through machine learning and natural language processing.
- **AI research tools** are advanced computational tools designed to support scholarly research by enabling semantic search, automated summarization, citation analysis, and intelligent data processing.
- AI research tools are information retrieval and knowledge-management systems that employ artificial intelligence to improve access to, evaluation of, and interaction with scholarly literature.
- AI research tools are smart computer tools that help researchers-to find, understand, and write research faster and more accurately.

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Characteristics of AI Research Tools:

- Use Machine Learning (ML) and NLP
- Perform semantic search
- Provide automatic summaries and insights
- Assist in citation and reference management
- Support decision-making in research

Importance of AI Tools in Research

- AI tools play a crucial role in modern research by improving efficiency, accuracy, and quality.
- AI tools reduce human errors, save time and cost, and support academic writing, citation management, and plagiarism detection.
- They help researchers in fast literature searching, identifying research gaps, designing methodology, and analyzing large datasets.
- On the whole, Artificial Intelligence need and useful in social science,, to enhance research productivity and innovation.

Artificial Intelligence and Social Sciences Research

Artificial Intelligence refers to computer systems capable of performing tasks that normally require human intelligence, such as learning, reasoning, pattern recognition, and language processing. In social sciences research, AI supports decision-making and enhances analytical capabilities.

AI tools do not replace researchers but act as research assistants, helping scholars handle large volumes of data, identify patterns, and synthesize information. The integration of AI into research practices represents a shift toward data-driven and evidence-based social inquiry.

Types of AI Tools Social Science Research:

There are many types of AI tools are using in academic writings in general, social sciences research in particular. AI Tools are using in research- to gather accurate identifying the research are or topic, finding research gaps, relevant review of related literature, , to prepare research design, hypotheses, framing the objectives, and for research process.

Some of the following AI research tools:

- ChatGPT: As we know well, ChatGPT is very popular AI tool, which is used by the different sections of the people of the society, to full-fill their needs, especially business, scientists, researchers and many others. The ChatGPT-openAI, which is the latest version of GPT 5.2 is used for generating research ideas/thinking, refining research questions, summarizing research articles, and explaining theoretical concepts. It assists researchers in drafting outlines, understanding complex theories, and preparing literature review summaries. With this tool, most of the time will be saved, supports academic writing and also it improves the conceptual clarity.
- Google Scholar: This is a very popular AI tool world-wide. It provides different types academic research information. Google Scholar uses AI-driven algorithms to retrieve scholarly articles, theses, books, and conference papers. It provides citation counts, related articles, and author profiles.
- Elicit: This is another important tools for research. Elicit is an AI-powered research assistant designed for systematic literature reviews. It extracts key information such as research methods, variables, and findings from academic papers.
- ResearchRabbit: ResearchRabbit visualizes citation networks and research trends, enabling researchers to explore relationships among studies and authors. This AI tool helps understand research gaps, identifies popular authors and it supports research.
- Scite.ai: Scite analyzes citations to show whether a study supports, contradicts, or merely mentions previous research.

Research Design and Data Collection

AI tools assist researchers in developing questionnaires, interview schedules, and research instruments. Chatbots and online survey platforms integrated with AI help in collecting large-scale data efficiently.

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AI Tools used in Data Analysis:
AI Assisted NVivo: NVivo is widely used for qualitative data analysis, including interviews; focus groups, and social media content. AI features assist in auto-coding and theme detection. Basically, this tool is used in- Speeds up qualitative analysis, Improves consistency in coding

- Statistical Software For Social Sciences (SPSS-1975): The SPSS with AI Features: supports statistical analysis in quantitative social sciences research. AI-enhanced features help interpret results and suggest appropriate statistical tests. The SPSS is mainly used for data analysis, i.e. complex statistical analysis.
- Grammarly: Grammarly improves grammar, clarity, academic tone, and coherence in research writing. AI-based plagiarism alerts help maintain originality.
- Reference Management Tools: Tools such as Zotero, EndNote, and mendelooly assist in organizing references and formatting citations in APA, MLA, and other styles. This AI Tools saves time in reference management and prevents plagiarism.

The Prospects:

- **Enhanced Research Efficiency**: This AI tool- automates time-consuming tasks, such as- literature search, data cleaning, and reference management and Researchers can focus on critical thinking and innovation.
- **Improved Literature Discovery**: These AI tools are based semantic search and recommendation systems, Automatic summarization of large volumes of research.
- **Advanced Data Analysis**
  - Handles big and complex datasets
  - Supports predictive analytics, text mining, and sentiment analysis
  - Benefit: Deeper insights and improved accuracy in findings.
- **Support for Interdisciplinary Research**
  - Integrates data from multiple disciplines
  - Encourages collaborative and cross-domain research
  - Assistance in Academic Writing
  - Improves language quality and clarity
  - Helps structure research papers and reports
  - Benefit: Higher-quality scholarly communication.
- **Increased Research Accessibility**
  - Assists researchers with limited resources
  - Enables multilingual translation and inclusive research
  - Benefit: Democratization of knowledge creation.

The Problems
The following problems are occurred in Social science Research, while using AI tools. They were discussed below in brief:

- Bias and Discrimination: AI tools can inherit biases from training data, leading to skewed research outcomes. It's important to validate AI-generated content against credible sources to avoid perpetuating stereotypes.
- Plagiarism Concerns: AI-generated content can resemble existing work, increasing plagiarism risks. Researchers ensure originality and maintain research integrity
- Data Misinformation: AI tools may generate inaccurate data and information. Always cross-check AI output with reliable sources to avoid spreading misinformation in your research.

The Challenges

- Accuracy & Integrity: AI can fabricate information or citations, requiring careful human verification.
- Ethics: Concerns exist regarding plagiarism and the appropriate level of AI involvement in core academic tasks.
- Accessibility: Disparities in resources (internet, electricity) can limit AI's benefits, especially in the Global South.

The Future of AI in Research

- Artificial Intelligence (AI) is rapidly transforming the global research eco-system. In the coming years,

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- AI will not only support research activities AI is becoming a fundamental tool, expected to design experiments, conduct peer reviews, and improve reproducibility, ushering in an era of faster scientific breakthrough..
- The future of AI involves the expansion of the technology`s role in day-to-day life, from performing data analysis and research to assist with human care.

Conclusion

AI tools have become indispensable in social sciences research by enhancing efficiency, accuracy, and scholarly communication. From literature search and data analysis to writing and research ethics, AI supports researchers at every stage of the research process. However, AI should be used as a supportive tool rather than a substitute for human intellect. Responsible and ethical use of AI ensures that social sciences research remains credible, inclusive, and impactful in the digital age.

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FROM ACCUMULATION TO OPTIMIZATION: STRATEGIC DELETION AS A GREEN SCIENTIFIC PRACTICE

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ABSTRACT

The physical sciences are currently facing a "data deluge," driven by high-resolution sensors, global observatories, and exascale simulations. Traditionally, digital libraries and repositories have prioritized total data preservation. However, the carbon footprint of the hardware, cooling, and power required to maintain these "forever archives" is no longer negligible. This paper proposes a paradigm shift toward strategic deletion. By moving from indiscriminate accumulation to targeted optimization, the scientific community can reduce its environmental impact while simultaneously maintaining the integrity of the scholarly record. We examine the technical, ethical, and ecological frameworks necessary to implement "green deletion" in the physical sciences. Central to this framework is the development of reproducibility-aware pruning algorithms and tiered metadata standards that differentiate between high-entropy, irreplaceable observations and redundant, computationally recoverable outputs.

Furthermore, we address the cultural resistance to data loss within academia and propose "value-over-volume" metrics to incentivize sustainable curation. By integrating life-cycle assessments into data management plans, institutions can transform digital infrastructure from a carbon liability into a lean, precision-oriented asset. This shift not only reduces the ecological cost of discovery but also ensures the long-term financial viability of open-access repositories in an era of dwindling resources.

Keywords: *Green Data Management, Strategic Deletion, Digital Sustainability, Data Deluge, Reproducibility, Carbon Footprint, Physical Sciences, Life-Cycle Assessment.*

Introduction: The Crisis of Infinite Storage

The physical sciences have entered the era of Exascale computing. In fields such as high-energy physics (HEP) and astronomy, repositories now measure data in petabytes and exabytes. While the ability to capture trillions of data points from cosmic observatories or particle accelerators is a tremendous engineering achievement, it has led to a "data deluge". Historically, the scientific mindset has been to "save everything". This was based on the falling cost of storage, making "delete" a forgotten command. However, we have reached a point where the environmental cost—measured in gigawatts of electricity and metric tons of CO_2—outpaces the scientific utility of raw data.

The Environmental Cost of "Cold" Data

Not all data is active. A significant portion of physical science repositories consists of "cold data"— data represents the vast datasets (especially in physical sciences) that remain unaccessed for years but are kept "just in case".

Source of Impact	Description
Electricity	Even "idle" storage requires power. While tape libraries are more efficient, they still require climate-controlled environments and robotic systems to retrieve cartridges.
Thermal Management	To prevent hardware degradation, data centers maintain strict temperature and humidity levels, leading to high Power Usage Effectiveness (PUE) ratios where a significant chunk of energy goes toward non-computing tasks.
E-Waste & Lifecycle	Rapid hardware turnover (typically every 3–5 years) to maintain reliability leads to significant e-waste. Only a small fraction of specialized storage hardware is currently recycled effectively.

The Methodology of "Green Deletion"

This introduces a paradigm shift in data management, moving away from "hoarding" toward a lean, sustainable lifecycle for scientific information.

Core components of the Green Deletion methodology:

(1) Technical Pillars of Deletion

The strategy moves the decision-making process from subjective human choice to objective, algorithm-driven curation.

A. Reproducibility-Aware Pruning

- The "Re-run Cost" Logic

  The core mechanism is a comparison between two physical costs:

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- Static Storage Cost: The cumulative CO_2 emitted to power the servers, cooling systems, and humidity controls required to keep a file bit-perfect for 5 years.
- Dynamic Regeneration Cost: The one-time burst of energy required to run the original code and metadata on a high-performance computer to recreate that exact output.

- The Pruning Threshold: We define the threshold for strategic deletion as the intersection where a dataset's Cumulative Storage Debt—the aggregate carbon and financial cost of maintenance—exceeds its Recomputation Opportunity Cost. Under this framework, data is flagged for transition or purging when the projected environmental impact of localized storage over a three-year epoch surpasses the energy expenditure required for algorithmic regeneration on demand.
- The Goal: To reduce the "carbon debt" of massive raw outputs that are rarely accessed but consume constant electricity for server cooling and maintenance.

B. Tiered Metadata Standards

This framework categorizes data by its irreplaceability rather than its size.

Tier	Classification	Example	Retention Policy
Tier 1	Eternal	A one-time astronomical event (Supernova).	Permanent storage.
Tier 2	Intermediate	Complex climate models with high CPU costs.	10-year review cycle.
Tier 3	Transient	Temporary test files or draft simulations.	Immediate deletion post-peer review.

(2) The Value-to-Carbon (V2C) Ratio

The V2C ratio provides a mathematical justification for data storage. It forces researchers to justify the environmental cost of their digital footprint.

The formula effectively measures Efficiency:

$$V2C = \frac{(Citations + Downloads) \times Impact\ Factor}{Annual\ Energy\ Consumption(kWh) \times CO_2\ intensity}$$

High V2C: Data that is frequently cited or used but has a small storage footprint (High Value).

Low V2C: Massive "dark data" sets that are never accessed but emit significant CO_2 through server maintenance (High Carbon).

The methodology argues that true knowledge isn't found in the sheer volume of bits, but in the ability to reproduce results. By "pruning" the digital library, we ensure that the energy we spend on data storage is directly proportional to the scientific value that data provides to humanity.

Challenges: The Fear of Losing the "Black Swan"

This section addresses the psychological and scientific hurdles of "Green Deletion". The "Black Swan" theory represents the anxiety that by deleting data to save the planet, we might accidentally destroy the next great discovery.

(A) The "Black Swan" refers to a high-impact, unpredictable event. In data science, this is the fear that a "discarded" outlier in a dataset might actually have been the key to a new physical law or medical cure.

I. Improved Metadata: Precision Tagging

To prevent accidental loss, this suggests that deletion cannot occur without semantic certainty.

The Solution: Moving beyond simple file names to "Context-Rich Metadata".

The Result: Before a file is purged, the system must confirm that its unique characteristics (e.g., specific anomalies or sensor conditions) are either documented elsewhere or are reproducible. This ensures we aren't deleting the "needle" while trying to get rid of the "haystack".

II. Algorithm Efficiency: Structural Skeletization

Instead of a binary "Keep or Delete" choice, the paper proposes a middle ground: Data Summarization.

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Skeletal Representation: AI algorithms can extract the "features" or "weights" of a massive dataset, creating a compressed version that retains the statistical significance of the original.

Lossy but Logical: While the raw, byte-for-byte data is purged, the knowledge structure remains. If a "Black Swan" exists in the patterns of the data, the skeleton should theoretically preserve it, allowing researchers to decide if the energy-intensive "re-run" of the full dataset is warranted.

(B) The Cultural Shift

Ultimately, this section argues that the risk of losing a "Black Swan" must be weighed against the certainty of environmental degradation. It shifts the burden of proof: data is no longer "innocent until proven guilty" (kept by default); it must prove its ongoing value to justify its carbon footprint.

Ethical and Ecological Frameworks

The core ethical challenge is balancing the Right to Know (scientific transparency) with the Right to a Sustainable Future (ecological preservation). The paper proposes a "Do No Harm" approach via two mechanisms:

I. The International Registry of Deleted Data (IRDD)

- To prevent "scientific amnesia", the paper suggests that no data should be deleted without leaving a permanent digital trace.
- The Concept: A global, open-access ledger - similar to a DOI system - that catalogs what was deleted and why.
- The "Shadow" Record: While the raw bits ('1's and '0's) are purged, the metadata, provenance, and V2C score remain.
- Discovery: A future researcher can see that an experiment was conducted, view the summary/skeleton of the results, and find the "seed" (code/parameters) needed to recreate the data if they have the energy budget to do so.

II. Transparency and Accountability

- The framework establishes that deletion is a citable event.
- Citation of Deletion: If a researcher uses a "skeleton" of a deleted dataset, they cite the original experiment and the IRDD entry.
- Peer-Reviewed Purging: Tiers 2 and 3 data (Intermediate and Transient) require a "deletion sign-off" from institutional review boards or peer reviewers, ensuring that the scientific community agrees the data's storage cost outweighs its utility.

Comparison: Traditional vs. Green Data Lifecycle

Feature	Traditional Lifecycle	Green Deletion Lifecycle
Default Action	Hoard indefinitely ("Just in case").	Prune based on V2C Ratio.
Traceability	Data is often lost in "dark" servers.	Permanent entry in the IRDD.
Energy Use	Linear increase over time.	Stabilized through constant curation.
Ethics	Focus on preservation only.	Focus on "Preservation vs. Carbon"

Conclusion

The conclusion of this paper serves as a vital manifesto for the future of scientific data management, arguing that sustainability must be integrated as a core pillar of Open Science. By moving away from the paradigm of "hoarding by default" and adopting strategic deletion, the physical sciences can demonstrate that intellectual progress does not require infinite digital growth.

This shift transforms the researcher's role from a passive collector to a deliberate curator. The digital library of the future is envisioned not as a sprawling warehouse of "dark data", but as a lean, intentional, and green ecosystem. In this new model, the value of a dataset is measured not by its volume, but by its utility and its environmental cost. Ultimately, by pruning the redundant and the reproducible, we protect the most vital records of human discovery while ensuring that the pursuit of knowledge does not come at the expense of the planet.

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EMERGING TECHNOLOGIES IN ACADEMIC LIBRARIES AI, ML AND AUTOMATION IN LIBRARY SERVICES INTEGRATION OF AUGMENTED AND VIRTUAL REALITY INTERNET OF THINGS (IOT) APPLICATIONS

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ABSTRACT
Emerging technologies are redefining academic libraries by transforming them into intelligent, flexible, and user-cantered knowledge environments. The integration of Artificial Intelligence, Machine Learning, Automation, Augmented Reality, Virtual Reality, and the Internet of Things enhances service quality, operational efficiency, and user engagement. These technologies enable libraries to effectively support teaching, learning, and advanced research activities in the digital age.

Keywords: *Emerging Technologies in Academic Libraries AI, ML, Automation, Library Services Integration, Augmented Virtual Reality, Internet of Things Applications*

Introduction

Academic libraries form the core knowledge support system of educational institutions such as schools, colleges, universities, and research organizations. Traditionally, libraries focused on the collection, organization, and dissemination of printed resources. However, the rapid growth of digital information and technological advancements has significantly transformed the role of academic libraries. Today, libraries are not merely repositories of books but dynamic learning environments that support teaching, research, innovation, and lifelong learning.

With the emergence of advanced technologies, academic libraries are adopting intelligent systems to improve access to information, enhance user experience, and optimize internal operations. Technologies such as Artificial Intelligence (AI), Machine Learning (ML), Automation, Augmented Reality (AR), Virtual Reality (VR), and the Internet of Things (IoT) are reshaping library services and redefining the interaction between users and information resources. These technologies enable libraries to function as smart knowledge hubs capable of meeting the evolving expectations of digital-age learners and researchers.

Academic Libraries: Concept and Types

An academic library is an information centre attached to an educational institution with the primary objective of supporting the academic curriculum, teaching-learning process, and research activities. Academic libraries contribute significantly to intellectual development by providing access to scholarly resources in both print and digital formats.

Types of Academic Libraries:

- School library: School libraries play a crucial role in nurturing reading habits and basic information skills among students. They support the school curriculum and encourage curiosity, creativity, and independent learning from an early stage.
- college library: College libraries cater to undergraduate and postgraduate students. They provide textbooks, reference materials, journals, and digital resources that support classroom learning and introductory research activities.
- University library: University libraries act as central knowledge centers serving students, faculty members, and research scholars. They maintain extensive collections, including e-resources, research databases, theses, and dissertations, to support advanced academic and research needs.
- Research Libraries: Research libraries focus on specialized and advanced research. Their collections include scholarly journals, technical reports, patents, datasets, and other research-oriented materials that support innovation and knowledge creation.

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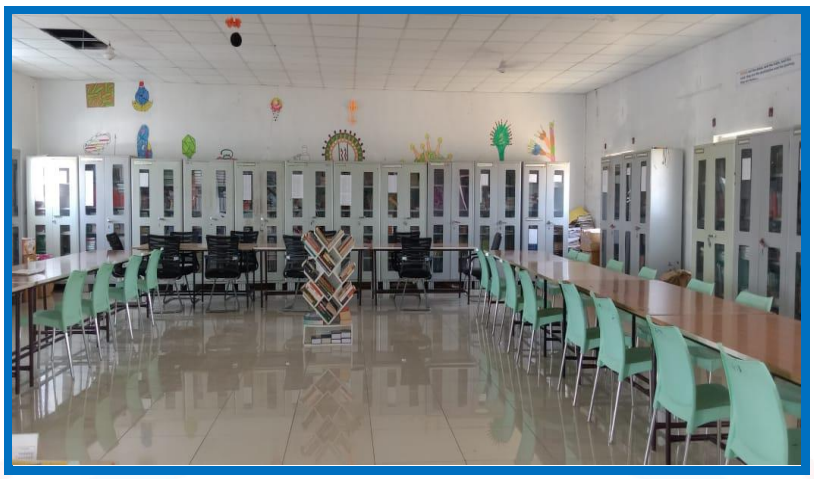

Objectives of Academic Libraries

- To support institutional curriculum and academic programs
- To provide quality resources for teaching and learning
- To facilitate research and scholarly communication
- To develop information literacy and digital skills
- To preserve and organize academic knowledge for future use

Importance of Academic Libraries

Academic libraries contribute directly to the overall quality of education and research within institutions. They promote independent learning, encourage a research-oriented culture, and provide access to reliable and authentic scholarly information. By offering diverse resources and professional guidance, libraries help users develop critical thinking, analytical abilities, and ethical use of information.

Emerging Technologies in Academic Libraries

The adoption of emerging technologies has become essential for academic libraries to remain relevant in a rapidly changing information environment. These technologies improve service efficiency, enhance user satisfaction, and enable libraries to manage growing volumes of digital information effectively.

1. Artificial Intelligence, Machine Learning and Automation in Library Services

Artificial Intelligence refers to the ability of computer systems to perform tasks that normally require human intelligence, such as reasoning, decision-making, and language understanding. Machine Learning, a subset of AI, allows systems to learn from data and improve performance over time. Automation involves the use of technology to perform routine library operations with minimal human intervention.

In academic libraries, AI, ML, and automation are increasingly used to enhance service delivery and operational efficiency. Intelligent search systems help users retrieve relevant information quickly, while chatbots and virtual assistants provide round-the-clock support for common queries related to library services. Automated cataloguing and metadata generation reduce manual effort and improve accuracy. Recommendation systems analyse user behaviour to suggest relevant books, articles, and databases.

These technologies significantly reduce repetitive tasks, improve accuracy in information processing, and enable library professionals to focus on user engagement, research support, and knowledge management.

2. Integration of Augmented Reality and Virtual Reality

Augmented Reality enhances the real-world environment by overlaying digital content, while Virtual Reality creates immersive computer-generated environments. The integration of AR and VR technologies in academic libraries offers innovative ways of accessing information and engaging with learning resources.

AR-based applications assist users in navigating library spaces and locating resources efficiently. Virtual library tours and orientation programs help new users familiarize themselves with library facilities. VR environments support immersive learning experiences, such as virtual exhibitions, simulations, and interactive educational content.

The use of AR and VR improves user engagement, enhances understanding of complex concepts, and provides flexible access to library services, especially for remote and distance learners.

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3. Internet of Things (IoT) Applications in Libraries

The Internet of Things refers to a network of interconnected physical devices embedded with sensors and software that enable data collection and communication. In academic libraries, IoT technology plays a vital role in creating smart and efficient library environments.

IoT-based applications include RFID-enabled circulation systems, smart shelves for real-time inventory management, environmental monitoring for preservation of resources, and occupancy tracking for optimal space utilization. Security systems integrated with IoT help prevent loss of library materials and ensure user safety.

The implementation of IoT enhances resource management, improves operational efficiency, and supports data-driven decision-making in library administration.

Challenges in Adopting Emerging Technologies: Despite the numerous advantages of emerging technologies, academic libraries face several challenges in their adoption and implementation. Financial constraints remain a major barrier, especially for institutions with limited budgets. The cost of technological infrastructure, software licenses, maintenance, and upgrades can be substantial. In addition, there is a continuous need for skilled manpower to manage and operate advanced systems.

Another challenge is the lack of technical expertise among library professionals. While emerging technologies offer great potential, their effective use requires proper training and continuous professional development. Resistance to change among staff and users may also slow down technology adoption. Data privacy, ethical concerns, and security issues related to AI and IoT systems further complicate implementation.

Role of Librarians in the Technological Environment

In the digital era, the role of librarians has evolved significantly. Librarians are no longer limited to traditional functions such as cataloguing and circulation. They are now expected to act as information managers, technology facilitators, research supporters, and digital literacy trainers.

Librarians play a crucial role in selecting appropriate technologies, guiding users in accessing digital resources, and ensuring ethical use of information. Continuous skill development in areas such as data management, digital tools, and emerging technologies is essential for librarians to remain relevant. Their active involvement ensures that technology serves academic goals rather than becoming an end in itself.

Future Trends in Academic Libraries

The future of academic libraries is closely linked to technological innovation. Libraries are expected to move towards fully integrated digital ecosystems where physical and virtual services coexist seamlessly. AI-driven analytics will support personalized learning experiences, while immersive technologies such as AR and VR will become common tools for education and research. Collaboration between libraries, academic institutions, and technology providers will play a key role in shaping future services. Open-access initiatives, cloud-based library systems, and data-driven decision-making are likely to dominate the academic library landscape. These trends highlight the need for strategic planning and adaptability.

Conclusion

Emerging technologies are redefining academic libraries by transforming them into intelligent, flexible, and user-cantered knowledge environments. The integration of Artificial Intelligence, Machine Learning, Automation, Augmented Reality, Virtual Reality, and the Internet of Things enhances service quality, operational efficiency, and user engagement. These technologies enable libraries to effectively support teaching, learning, and advanced research activities in the digital age. To achieve sustainable growth, academic libraries must address challenges related to funding, skills, and infrastructure while embracing innovation. Librarians play a vital role in bridging the gap between technology and users. With thoughtful planning and responsible implementation, emerging technologies will ensure that academic libraries continue to serve as dynamic centres of knowledge and lifelong learning.

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ROLE OF DIGITAL LIBRARIES IN SOCIAL SCIENCES, LIFE SCIENCES, AND PHYSICAL SCIENCES

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ABSTRACT
Digital libraries are cornerstone resources in contemporary science and education. By providing inclusive access, efficient research tools, multimedia content, and robust archival solutions, they enhance the quality and reach of scholarly work across social sciences, life sciences, and physical sciences. Their continued evolution will further empower researchers, educators, and learners ensuring that knowledge remains accessible, dynamic, and relevant in a rapidly changing academic world.

Keywords: Digital Libraries, Social Sciences, Life Sciences, Physical Sciences

Introduction

In the modern age of digital transformation, digital libraries have become central to academic research, teaching, and innovation across all scientific disciplines. Unlike traditional libraries confined to physical spaces, digital libraries store and provide access to electronic books, research articles, datasets, multimedia content, and interactive resources online. Their growth reflects the global shift toward online education, open science, and connected research communities. Digital libraries are no longer optional they are essential tools shaping how knowledge is accessed, shared, and preserved.

Digital Libraries

A **digital library** is an organized collection of informational resources in digital form. These resources are accessible remotely via the internet or institutional networks and are often enriched with search tools, metadata, and interactive features that enhance user experience. Digital libraries support:

- Full-text search and indexing
- Multimedia content (audio, video, simulations)
- Datasets and linked research tools
- Real-time updates and interactive learning modules

Digital libraries bridge the gap between vast global information and the immediate needs of students, researchers, and educators.

General Advantages of Digital Libraries

Digital libraries offer several powerful benefits that impact all scientific disciplines. A digital library is a collection of information resources such as e-books, e-journals, research papers, images, audio, and video stored in digital format and accessed through computers and the internet. Digital libraries play an important role in teaching, learning, and research across all fields of knowledge. Here I would like to explained by below.

- Accessibility and Reach

  Users can access digital libraries anytime, anywhere, provided they have an internet connection. This eliminates geographical constraints and extends educational opportunities to underserved and remote regions.
- Enhanced Research Efficiency

  With advanced search tools, users can locate specific information using keywords, filters, and metadata, greatly speeding up research and discovery.
- Cost-Effective and Sustainable

  Digital resources reduce the cost of printing, physical storage, and maintenance, making access to knowledge more sustainable and affordable.
- Multimedia and Interactive Learning

  Digital libraries integrate video, audio, and interactive modules, catering to diverse learning styles and supporting complex scientific concepts.
- Preservation and Archiving

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Digitizing rare manuscripts, historical books, and fragile academic materials protects them from physical degradation and provides long-term preservation

Role in Social Sciences

In social sciences, digital libraries are transforming research and teaching by making vast social data, surveys, policy documents, and cultural materials accessible in one place. Traditional barriers of physical access, especially in history, anthropology, sociology, and economics, are being dismantled. Researchers can now:

- Search across datasets, publications, and question banks linked in one digital platform.
- Re-use and compare social data for new insights in policy, behaviour, and societal trends.
- Connect literature with empirical data for deeper interdisciplinary analysis.

Digital libraries also support open access publishing, where research outputs have broader reach and higher visibility in social discourse. This increases the potential for societal impact and citation by scholars worldwide.

Role in Life Sciences

The life sciences benefit significantly from digital libraries because they often rely on large datasets, evolving research outputs, and integrated knowledge systems. Specific contributions include:

- Centralized access to scientific literature, protocols, and biological datasets.
- Supporting data-intensive research in genomics, ecology, and medicine.
- Encouraging cross-institution data sharing and collaborative discovery.

Historical medical collections, such as those curated in digital medical libraries, also enrich research by providing archived references that supplement contemporary studies.

Furthermore, digital libraries often incorporate simulation tools, interactive models, and visual data that are vital in life science education and laboratory training.

Role in Physical Sciences

In physical sciences (e.g., physics, chemistry, engineering), digital libraries facilitate advanced research by providing:

- Access to discipline-specific journals, experimental data, simulation results, and technical standards.
- Interdisciplinary access that allows physical scientists to integrate knowledge from mathematics, computer science, and applied engineering.
- High-performance datasets and modeling tools that support hypothesis development and verification.

The flexibility of format from text to interactive simulations and visualizations helps researchers grasp abstract physical concepts more readily. Additionally, digital preservation ensures data used in long-term longitudinal studies remains available for future use.

Impact on Academic Performance and Learning

Recent studies show that digital libraries enhance academic performance in educational institutions by improving access to learning resources and supporting independent research skills. Students with access to digital libraries exhibit stronger research capabilities, deeper critical thought, and better academic outcomes.

Digital libraries also promote lifelong learning by enabling self-directed study beyond the classroom, encouraging learners to explore topics independently and build research competencies for career advancement.

Challenges and Future Directions

Despite their many benefits, digital libraries face challenges:

- **Digital Divide**: Limited internet or device access can exclude users in certain areas.
- **Information Literacy**: Users need the skills to navigate vast digital collections and distinguish credible sources.
- **Technology Investment**: Institutions must invest in robust infrastructure, cybersecurity, and continuous upgrades.

Looking forward, digital libraries are expected to integrate AI-driven search, personalized recommendations, and data analytics, enhancing research efficiency and user experience. Cross-institution open repositories and collaborative platforms will further democratize access to scientific knowledge.

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Conclusion

Digital libraries are cornerstone resources in contemporary science and education. By providing inclusive access, efficient research tools, multimedia content, and robust archival solutions, they enhance the quality and reach of scholarly work across social sciences, life sciences, and physical sciences. Their continued evolution will further empower researchers, educators, and learners ensuring that knowledge remains accessible, dynamic, and relevant in a rapidly changing academic world.

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शैक्षणिक पुस्तकालयों में डिजिटल परिवर्तन: चुनौतियाँ और अवसर

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ABSTRACT

In the 21st century, Information and Communication Technology (ICT) has brought about unprecedented transformations in the fields of education, research, and knowledge management. Academic libraries, traditionally considered to be limited to printed books and journals, are now evolving into digital information centers. In line with the concept of Library Science 5.0, artificial intelligence, digital repositories, e-resources, online databases, and automated services are making library operations faster, more efficient, and user-centric. This research paper aims to conduct a detailed study of the need, process, challenges, and potential opportunities of digital transformation in academic libraries. The study is based on a descriptive and analytical research methodology and analyzes literature and data obtained from secondary sources. The findings indicate that, with appropriate policies, training, and technological resources, digital libraries can make a significant contribution to the quality of education and research.

Keywords: *Academic libraries, Digital transformation*

प्रस्तावना

पुस्तकालय किसी भी शैक्षणिक संस्था का बौद्धिक और अकादमिक केंद्र होता हैं। यह न केवल शिक्षण-अधिगम प्रक्रिया को सुदृढ़ बनाता है, बल्कि शोध, नवाचार और ज्ञान प्रसार में भी महत्वपूर्ण भूमिका निभाता है। परंपरागत पुस्तकालय सेवाएँ मुद्रित संसाधनों के संग्रह, संरक्षण और वितरण तक सीमित थीं। डिजिटल युग के आगमन के साथ सूचना की प्रकृति, स्वरूप और उपयोगिकर्ताओं की अपेक्षाएँ व्यापक रूप से बदल गई हैं। आज विद्यार्थी और शोधकर्ता त्वरित, सटीक और ऑनलाइन सूचना की अपेक्षा रखते हैं। इंटरनेट, ई-पुस्तकें, ई-जर्नल और ऑनलाइन डेटाबेस ने सूचना प्राप्ति को सरल, तेज और व्यापक बना दिया है।

Library Science 5.0 की अवधारणा पुस्तकालयों को मानव-केंद्रित, तकनीक-सक्षम और सामाजिक रूप से उत्तरदायी बनाने पर जोर देती है। इसमें कृत्रिम बुद्धिमत्ता, डेटा एनालिटिक्स और स्वचालन की महत्वपूर्ण भूमिका है। डिजिटल परिवर्तन वर्तमान समय में शैक्षणिक पुस्तकालयों की अनिवार्य आवश्यकता बन चुका है।

साहित्य समीक्षा

राष्ट्रीय एवं अंतरराष्ट्रीय स्तर पर किए गए अध्ययनों से स्पष्ट हुआ है कि डिजिटल तकनीकों के प्रयोग से पुस्तकालय सेवाओं की पहुँच और गुणवत्ता में उल्लेखनीय वृद्धि हुई है। IFLA और UNESCO की रिपोर्टों में डिजिटल पुस्तकालय सेवाओं की दीर्घकालिक संभावना, उपयोगकर्ता संतुष्टि और शिक्षा की गुणवत्ता सुधारने में योगदान को रेखांकित किया गया है। भारतीय संदर्भ में सिंह (2022) ने Library Science 5.0 की भविष्य की पुस्तकालय व्यवस्था के रूप में वर्णित किया है, जिसमें तकनीक और मानवीय मूल्यों का संतुलन आवश्यक है। कुमार (2023) के अध्ययन के अनुसार, AI आधारित सेवाएँ जैसे चैटबॉट, अनुशंसा प्रणाली और स्वचालित अनुक्रमण पुस्तकालय उपयोगकर्ताओं के अनुभव को बेहतर बनाती हैं। डिजिटल परिवर्तन शैक्षणिक पुस्तकालयों के सतत विकास के लिए अनिवार्य है, और इसका प्रभाव न केवल सूचना पहुँच पर, बल्कि शोध और सीखने की गुणवत्ता पर भी गहरा है।

उद्देश्य

- शैक्षणिक पुस्तकालयों में डिजिटल परिवर्तन की अवधारणा को समझना।
- डिजिटल परिवर्तन से जुड़ी प्रमुख चुनौतियों की पहचान करना।
- डिजिटल तकनीकों से उत्पन्न अवसरों का अध्ययन करना।
- Library Science 5.0 के संदर्भ में शैक्षणिक पुस्तकालयों की भूमिका का विश्लेषण करना।
- नीति निर्धारण और प्रशिक्षण आवश्यकताओं का सुझाव प्रस्तुत करना।

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अनुसंधान पद्धति

यह अध्ययन वर्णनात्मक और विश्लेषणात्मक शोध पद्धति पर आधारित है। इसमें प्राथमिक आँकड़ों के स्थान पर द्वितीयक स्रोतों का उपयोग किया गया। शोध के लिए सामग्री संकलन के स्रोत:

- पुस्तकों और शोध पत्रों
- सरकारी एवं गैर-सरकारी रिपोर्टें
- IFLA और UNESCO के प्रकाशन
- विश्वसनीय ऑनलाइन डेटाबेस

संकलित जानकारी का तुलनात्मक और विश्लेषणात्मक अध्ययन किया गया। अध्ययन में डिजिटल परिवर्तन की प्रक्रिया, चुनौतियों और अवसरों की विस्तृत व्याख्या की गई है।

शैक्षणिक पुस्तकालयों में डिजिटल परिवर्तन की चुनौतियाँ

डिजिटल परिवर्तन के समक्ष कई चुनौतियाँ उपस्थित होती हैं:

- वित्तीय संसाधनों की कमी
- डिजिटल अवसंरचना, सॉफ्टवेयर, लाइसेंस और हार्डवेयर पर उच्च लागत।
- प्रशिक्षित मानव संसाधनों की कमी
- पुस्तकालय कर्मियों को नई तकनीकों और AI आधारित सेवाओं का प्रशिक्षण देना आवश्यक।
- साइबर सुरक्षा और डेटा संरक्षण
- डिजिटल संसाधनों की सुरक्षा और उपयोगकर्ता डेटा की गोपनीयता सुनिश्चित करना।
- तकनीकी असमानता और डिजिटल विभाजन
- सभी उपयोगकर्ताओं के लिए समान डिजिटल सुविधा उपलब्ध नहीं होना।
- भाषा और उपयोगकर्ता बाधाएँ
- सामग्री की भाषा और डिजाइन उपयोगकर्ताओं की विविध आवश्यकता पूरी नहीं कर पाती।

तालिका 1 शैक्षणिक पुस्तकालयों में डिजिटल परिवर्तन की प्रमुख चुनौतियाँ

चुनौती	विवरण
वित्तीय संसाधन	डिजिटल लाइब्रेरी के लिए लागत अधिक
प्रशिक्षित स्टाफ	नई तकनीकों के लिए प्रशिक्षण आवश्यक
साइबर सुरक्षा	डेटा सुरक्षा सुनिश्चित करना
डिजिटल विभाजन	सभी के लिए समान सुविधा नहीं
भाषा/उपयोगकर्ता बाधाएँ	सामग्री उपयोगकर्ताओं की विविध जरूरतों को पूरा नहीं करती

डिजिटल परिवर्तन के अवसर

डिजिटल परिवर्तन शैक्षणिक पुस्तकालयों के लिए कई अवसर प्रदान करता है:

- 24×7 सूचना उपलब्धता
- उपयोगकर्ता किसी भी समय और स्थान से सूचना प्राप्त कर सकते हैं।
- AI आधारित सेवाएँ
- चैटबॉट, अनुशंसा प्रणाली, स्वचालित वर्गीकरण सेवाएँ।

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- डिजिटल रिपॉजिटरी और ई-संसाधन
- शोध कार्य को बढ़ावा और ज्ञान संरक्षण में मदद।
- ई-लर्निंग और ऑनलाइन कोर्स
- पुस्तकालयों की भूमिका को विस्तारित करना।
- डेटा एनालिटिक्स और उपयोगकर्ता अनुभव सुधार
- सेवाओं को व्यक्तिगत और प्रभावी बनाना।

तालिका 2 डिजिटल परिवर्तन से प्राप्त अवसर

अवसर	विवरण
24×7 सूचना	कहीं से भी सूचना उपलब्ध
AI सेवाएँ	चैटबॉट, अनुशंसा प्रणाली, स्वचालित वर्गीकरण
डिजिटल रिपॉजिटरी	शोध कार्य में मदद और ज्ञान संरक्षण
ई-लर्निंग	ऑनलाइन पाठ्यक्रमों के माध्यम से विस्तार
डेटा एनालिटिक्स	सेवाओं को व्यक्तिगत और प्रभावी बनाना

नीति और प्रबंधन सुझाव

- डिजिटल अवसंरचना के लिए पर्याप्त वित्तीय संसाधन उपलब्ध कराना।
- पुस्तकालय कर्मियों के लिए नियमित प्रशिक्षण और capacity building।
- साइबर सुरक्षा और डेटा प्रोटेक्शन के लिए SOPs और monitoring प्रणाली।
- सभी उपयोगकर्ताओं के लिए डिजिटल पहुँच सुनिश्चित करना।
- Library Science 5.0 आधारित प्रौद्योगिकी अपनाना और AI समाधानों का समावेश।

निष्कर्ष

अध्ययन से स्पष्ट हैकि शैक्षणिक पुस्तकालयों में डिजिटल परिवर्तन वर्तमान समय की अनिवार्य आवश्यकता है। डिजिटल तकनीकों और Library Science 5.0 के माध्यम से पुस्तकालय शिक्षा और शोध की गुणवत्ता में महत्वपूर्ण योगदान दे सकते हैं। वित्त, तकनीकी और मानव संसाधन संबंधी चुनौतियों के बावजूद, उचित नीतियाँ, प्रशिक्षण और तकनीकी सहयोग के माध्यम से समस्याओं का समाधान संभव है। भविष्य में डिजिटल परिवर्तन और AI आधारित Library Science 5.0 अवधारणा पुस्तकालयों को अधिक सशक्त, समावेशी और उपयोगकर्ता-केंद्रित बनाएगी।

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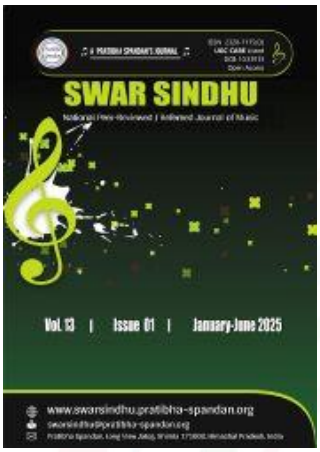
ABOUT PRATIBHA SPANDAN

Established in 2012 in Shimla, Himachal Pradesh, Pratibha Spandan is a multi-faceted society dedicated to holistic social transformation by bridging the gap between privilege and need. For over a decade, the organization has championed a wide array of initiatives, ranging from grassroots education, healthcare, and women's empowerment to environmental conservation and animal welfare. By uniquely integrating traditional culture and fine arts with modern innovation and IT skills, Pratibha Spandan acts as a vital catalyst for progress, aiming to build an equitable, sustainable, and empowered future for all sections of society.

JOURNALS, BOOKS, E-BOOKS

Journals



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https://swarsindhu.pratibha-spandan.org/

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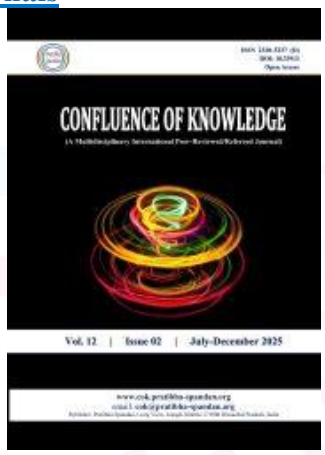

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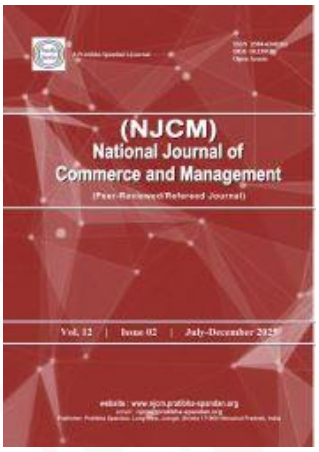

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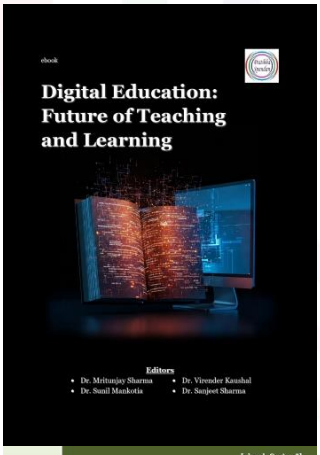

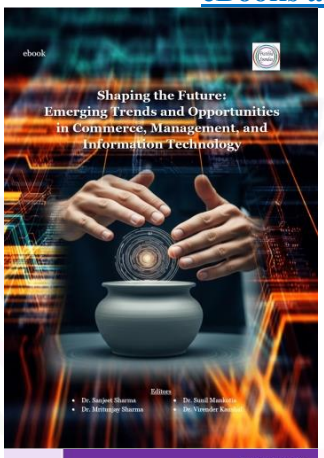

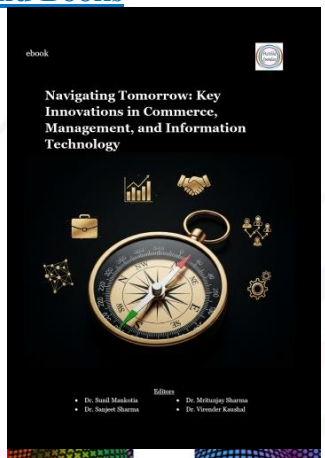

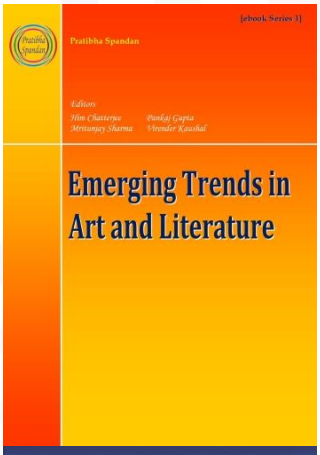

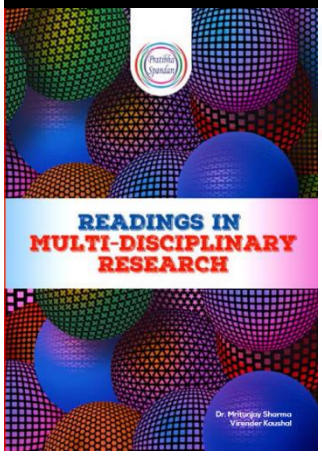

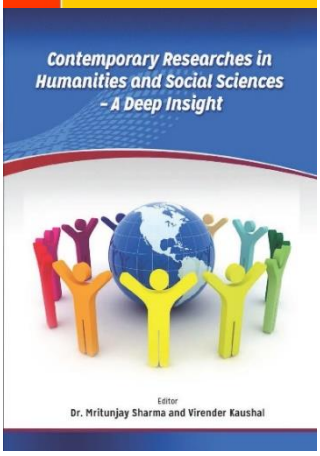

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