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The Tamil Nadu Dr. Ambedkar Law University journal of The Department of Library Science, a peer-reviewed journal, focuses on the research methodology in library science, notably cases of novel strategies, conceptual definitions and hypothesis development, as well as original attachments and uses of tried-and-true approaches and tools.

Research papers accepted and published by The Tamil Nadu Dr. Ambedkar Law University Journal of The Department of Library Science, have a wide range of innovative scientific viewpoints, techniques, and mixed-methodology analyses. TNDALUJDL provides progressive and state-of-the-art articles and critiques that educate, equip, equalize, guide, and inspire LIS field to adjust, modify and tailor to changes through distinctive and creative research material that places libraries at the intersection of information, community, and policy, all of the journal's content in these categories relates to current problems that have an impact on libraries and contemporary librarianship.

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Libraries in the Changing Dynamics of the Society

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Abstract

Information and communication technologies (ICTs) are the tools that have made it possible for the Information Society, Knowledge Society, Android Society, and now the Cyber-Physical Society to develop. Society is becoming more cyber-physical as a result of our growing reliance on ICTs in many facets of our daily lives, which emphasizes the significance of cyber security. This holds true for libraries and the field of librarianship as well. In today's digitally networked world, libraries have completely changed their structure due to re-engineering and revitalization. It explains how society is changing and how libraries are adapting in the current environment. This paper provides an overview of libraries' current and historical status in the digital age. Described are the extent of libraries and information storage devices, as well as the ways in which society is evolving. gives an estimate of the future of libraries and makes the prediction that they will be crucial to the country's development going forward, particularly in terms of sociocultural and educational enlightenment. Additionally, it highlights how libraries can foster creativity and innovation in the face of shifting societal dynamics and how academics and librarians can work together to bridge knowledge for a sustainable world. Future library challenges are also discussed.

Keywords: Libraries; Dynamics Of The Society; Future Libraries; Future Of Libraries;

INTRODUCTION

"Without the library, you have no civilization".

"Without libraries what have we? We have no past, no future".

Ray Bradbury

"*Libraries really are the gates to the future" --*

Neil Gaiman

"No one can predict the future with any real degree of certainty, but it sometimes seems as though everyone is giving it a try. Certainly, the future cannot be predicted accurately and prediction is not an exact science".

Bruce AShuman, 2001

Since the first libraries were founded in ancient Babylonia and Sumer, they have been vital repositories of uncommon, rare, and intellectual knowledge. People use libraries for purposes beyond reading, borrowing, and information retrieval, and they continue to play an important role in the community. By providing equal and free access to invaluable multicultural and multilingual resources, they support literacy and education while empowering communities with knowledge. Regardless of their nationality, ethnicity, age, gender, or social status, everyone is welcome and has access to them. They welcome independent thought and encourage the free and full exchange of ideas. Libraries encourage curiosity and creativity, giving people the freedom to fill their minds with the most valuable ideas and thoughts. Libraries are now more than just places to keep books or conduct searches. Their reputation as storage facilities or as index cards for massive physical holdings is rapidly eroding. Rather, they are developing into centers for resources that utilize state-of-the-art technology like digital collections, social media, and multimedia applications. A significant amount of the library's collection is now accessible digitally, and its main function has expanded beyond simply storing books. Libraries have changed significantly since computer access became widely available, and this change has been accelerating over time. They have embraced—and in certain instances, even promoted—new technologies and practices that have enhanced their ability to fulfill their main duty, which is to provide their clients with as much content as possible for educational and recreational purposes, among other uses. They are adapting to this change by rethinking the library as a dynamic, global center for communication and media.

LIBRARIES FROM EARLY TIMES

The services that the librarian provides are what define the library, not the actual location of the collections and information. Libraries simultaneously preserve and apply the traditional values and principles of librarianship in order to ensure high service standards. They remained largely unchanged from the start of the book until almost the end of the twentieth century. In the beginning, even the invention of computers led to the automation of libraries rather than a significant change. "*Libraries all along history have been at the receiving end. They have been disregarded, lowered in public esteem. One can trace only humble origins of the libraries. Libraries like some other social institutions have passed through periods of recognition, lull, encouragement, neglect followed by slow growth, decay and then crisis*" (Guruswamy Naidu, 2010).

The status of libraries in the prior eras are termed as follows:

- Stale image – the portrayal of librarians as dull and strict negatively impacts the perception of the profession.
- Low Expectations – library users often have minimal expectations regarding the quality of services offered by librarians.
- Obscurity – the role of a librarian is often overlooked, and the public is largely unaware of their actual responsibilities.
- Economic Impact – libraries contribute little to the nation's economic development.
- Service Quality – users typically lack awareness of the range of services librarians can provide or the quality of those services.

CHANGING DYNAMICS OF SOCIETY

In order to protect people from hunger, disease, pain, and other problems, inventions and ideas are developing at a faster rate. The transition from an agrarian, primitive tribal civilization to an industrial, information-based, and android-based society is the most significant change that has been seen so far. The state economy and pre-existing social ties have an impact on the controversial process of creating the information society. In his 1980 book "Third Wave," Alvin Toffler discussed the transition from prehistoric tribal society to post-industrial society. The First, Second, and Third Wave Societies, according to him, were all revolutionary developments. First Wave Society is composed of primitive/tribal and agrarian societies. Second Wave Society is composed of post-industrial and industrial societies. The Third Wave Society is comprised of knowledge, information, and information-literate societies. The extensive use of information technology is making society more dynamic and integrated.



Fig. 1 From Tribal Society to Artificial Intelligence Society (Ramesh Babu, 2023b)

Since mobile technology and its associated innovations were the driving force behind the subsequent information technology revolution, which advanced society and gave rise to the term "information society," we currently live in a civilization known as Android society. Our extensive use of ICT and the Internet in every aspect of our lives is turning us into a cyber-physical civilization (Fig. 1). Our society is evolving into a cyber-physical one, with ICT being used in every facet of daily life. It is linked to individuals who are flexible in both social and physical settings. The current Cyber-Physical society and the Information, Knowledge, and Android societies have arisen through ICTs. Our society is evolving into a cyber-physical one as a result of our increasing reliance on information and communication technology (ICT) in many facets of daily life, which emphasizes the significance of cybersecurity. This holds true

for libraries and the field of librarianship as well. The Cyber-Physical Society (CPS), a society of the future, combines engineering, science, and technology. With the rapid advancement of information technology, cyberspace is merging with social, mental, and physical spaces to form a new reality called the "Cyber Physical Society" (Zhuge, 2014). We can now declare that we live in an AI society due to the extensive use of artificial intelligence (AI) tools.

LIBRARIES IN THE DIGITAL ERA

More changes to libraries have been brought about by technology in the last forty years than in all the previous decades combined. The library has long since outgrown its initial function as a straightforward repository or search engine for physical collections and is now home to content produced using the newest technologies, including digital collections, social media, and multimedia resources. "Libraries without walls," which were previously unthinkable, are now practically a given. They find themselves on a precipice at the start of the digital era. The changing landscape for libraries in the present context is as follows:

1. Transitioning from Physical to Virtual Libraries – Striking a balance between traditional facilities and the growing demand for digital resources.
2. Evolving from Individual to Community Libraries – Meeting the requirements of individuals while fostering community involvement.
3. Shifting from Collection to Creation Libraries – Redefining libraries as spaces for media production rather than solely for consumption.
4. Moving from Portal to Archive Libraries – Achieving a balance between the physical and digital archiving needs.

CHANGING DIMENSIONS OF LIBRARIES

The library and information landscape is changing at a dynamic speed. Dramatic changes are in the offing for libraries as the result of the digital revolution and towards bridging knowledge for a sustainable world, such as:

- Changes in the form of library
- Changes in the relationship between an institution's library and its information technology division
- Changes in the way collections are acquired, organized, stored, and delivered
- Changes in the design of library buildings and facilities and in participation by libraries in consortia (Marcum, 2000).

The requirements and interests of the readers have also changed. They find it difficult to forecast the future learning preferences of Next Generation consumers. They are struggling to accommodate the various information needs of their clientele as part of their duty. Libraries' traditional operations have undergone significant modifications as a result of ICT. Digital technology's explosive growth presents libraries with both positive and negative problems.



Fig.2 Changing Dimensions of Libraries (Ramesh Babu, 2023a)

Certain library locations, including greenhouse libraries, are shifting from traditional to automated to electronic to digital/virtual/hybrid. Future library development is still being greatly influenced by advancements in digital technology. The digital revolutions in broadband, mobile devices, social networking, and cloud computing are causing physical libraries to undergo a fundamental shift into the digital sphere (Figure 2). These days, the creation of green libraries is valued in practically every nation. Libraries often consider the Leadership in Energy and Environmental Design (LEED) grading system when considering green design (Mahawariya, 2019 &Ankamurthy and Chandrasekhara, 2021).

DYNAMICS OF THE INFORMATION STORAGE MEDIA

The fig. 3 will illustrate the evolution of information storage media from stone age to web age over a period and it is estimated that it will further progress in different dimensions in due course of time (Ramesh Babu, 2004).

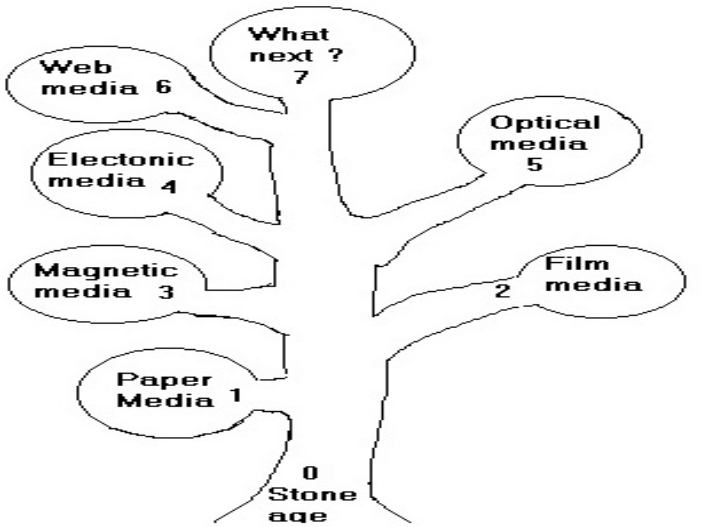

Fig: 3 Dynamics in the Information Storage Media (Ramesh Babu, 2004)

The library and information landscape is evolving rapidly, and the paradigm shift in information storage media is moving from document ownership to information access; the intermediary model of services is giving way to the end-user model. Print media is gradually being replaced by electronic information materials. One of the biggest challenges is managing the ever-expanding collections of electronic resources that libraries are creating. Many full-text aggregations, citation databases, and electronic journals are now owned by the majority of libraries. Libraries must provide their users with convenient access points and staff with the tools to keep an eye on these electronic resources. Thus, the concept of electronic resource management, or ERM, has emerged in the field of creative librarianship.

FUTURE LIBRARIES IN THE CONTEXT OF THE DYNAMICS OF SOCIETY

The National Knowledge Commission (NKC), India in its recommendations has rightly quoted libraries as 'Gateways of Knowledge' and has clearly outlined the role of libraries as,

"Libraries have recognised social function in making knowledge publicly available to all. They serve as local centres of information and learning and are local gateways to national and global knowledge". The pursuit of knowledge and libraries are timeless. However, libraries in the future must adapt to the changing times. Future libraries are not a thing of science fiction or a librarian's worst nightmare; rather, they are a dream come true. These are hybrid libraries. As a result, it is feasible to imagine libraries of the future as nothing more than enormous, air-cooled servers, spinning digital archives linked by digital networks, copying and distribution devices, and shelves devoid of any actual books or print books Some of the components of future libraries that will be essential in the near future include digital objects, metadata, repositories and harvesting, digital rights management, indexing, resource discovery, searching and retrieving, linking, interfaces and interaction, architectures, and interconnections. Future library development occurs in widely scattered environments.

In short, a future library is a "library without walls" or a digital library that is available online. In contrast to traditional libraries that rely on print materials, this refers to electronic resources that are accessible in person or remotely and do not have a physical location. In a future library or hybrid library, whether or not they are physically present in the library, anyone with a computer and access to the library's networks can access not only the library's resources but also a wealth of information available via intranets and other national and international networks, like the internet. In the future, libraries will be directories with content that librarians have arranged logically. It is a good idea to think of these specialized directories as being similar to libraries because the people who are committed to finding the best resources on the internet have meticulously selected and maintained the resources in a future library that are graded or assessed and ordered systematically.

The following user-centric trends will be reflected in future libraries:

- Modifications to the information-access communication system;
- Reduced maintenance costs and storage space;
- Enhanced search technologies
- Users' time-pressed lifestyles;
- Shifting from product-based to experience-based system platforms

The following are a some of the presumptions regarding the future libraries:

- Libraries are a tool, not a goal.
- Disruptive technologies can and will disrupt libraries.
- Minor tweaks here and there won't have a significant impact.

- If we don't wait too long, we still have time to make meaningful improvements(Lewis, 2007).

Libraries have a bright and exciting future ahead of them, with countless opportunities shaped by evolving technologies. The library of the future is the information resource of the third millennium and includes all recorded knowledge online (billions of items), distributed and maintained globally, and accessible to anyone in any language at any time, anywhere in the world, via the Internet. Libraries have been and will remain hubs for the creation of new knowledge and the access to information.

Therefore, the future of libraries depends on how the profession's ever-evolving work is handled in its three contexts: the larger social and cultural forces, other competing occupations, and competing organizations and commodities (Abbott, 1998, p 3). Libraries and librarianship, as well as LIS professionals, appear to have a bright future. The future Library and information services and professionals thrive best in an environment where: Individuals hold truth, knowledge, and justice in high regard and actively pursue them. Governments prioritize the freedom to access information and uphold freedom of expression. Citizens possess a natural curiosity and a desire to learn. Literacy is regarded as an essential competency. Engaging in reading for enjoyment is a widely embraced pastime. The significance of history and cultural heritage is recognized and appreciated. Information is readily available. Practices are grounded in evidence. There is a concerted effort to address and diminish inequality. A culture of sharing prevails within society. There is a sense of pride in civic and institutional frameworks. Investment in knowledge is considered crucial for achieving successful outcomes.

The IFLA Trend Report (2013) points to five high level trends that will change the library and information environment in future:

1. The availability of information will be both expanded and restricted by new technologies.
2. Online education will both democratize and disrupt global learning.
3. Redefining the parameters of data protection and privacy.
4. New voices and organizations will be heard and given influence in hyper connected society.
5. New technology will change the global information economy.

The IFLA Update 2021 shares 20 different suggested trends, some complementary, some contradictory, that the people who will be leading our field in ten years felt would mark their professional lives.

The trends forecasted by IFLA are:

1. Difficult times to come
2. Virtual is here to stay
3. Physical locations are making a comeback
4. Soft skills' ascent
5. Diversity gets taken seriously
6. An environmental reckoning
7. A nomadic population
8. The user who is impatient
9. A backlash in analog
10. Scale is important
11. Domination of data
12. Transformed search
13. Excessive racing
14. Lifelong learners
15. A single worldwide compilation
16. Knowledge privatization
17. Qualifications are important
18. Information literacy recognised
19. "Open" calls into doubt the distinctive selling proposition of libraries.
20. The disparities are worse (As of January 7, 2025, accessible at https://trends.ifla.org/update-2021).

Libraries are changing drastically. They are increasingly using them to connect with customers and promote their services. They have adopted a range of social media platforms, such as Facebook, Twitter, Pinterest, and YouTube, in order to interact with customers and advertise local resources and services (Witte, 2013). This pattern demonstrates how libraries produce information, including text, video, and other digital assets, using state-of-the-art technology. The traditional library function of being a physical location with book racks is becoming less and less relevant to the needs of scholars and students as technology changes our access to information at an accelerating rate and materials become more readily available in digital and online formats. The needs and preferences of library users are driving change in libraries in addition to technology. It is obvious that there has been a fundamental change in the information landscape and that this change will continue. Therefore, in order to be ready

for new tasks in the context of 21st century libraries, librarians in the third millennium will need to retool with new competencies and skills. This is the only way libraries can survive and thrive in the future.

FUTURE LIBRARIES' DIFFICULTIES IN THE CHANGING SOCIETY

According to Davis and Lundstrom (2011), *"libraries face a host of new challenges, among them finding ways to stay relevant in the Information Age. Libraries are required to do more with less, and the skills library professionals need continue to evolve".* The future of librarianship in India faces many challenges in the context of dynamics of the society.

The following are the challenges for libraries in India:

- Inadequate ICT infrastructure
- The absence of well-coordinated government efforts.
- Instability in politics
- Diversity in languages
- Economic considerations
- Psychological obstacles
- Barriers related to literacy and skills
- Barriers related to infrastructure
- Service Oriented challenges
- Difficulties in developing manpower
- Cost and infrastructure issues
- Issues with access and the domestic divide

In the ever-changing landscape of today's issues, librarians must play special and vital roles in influencing culture and cultivating individuals who uphold democratic norms. Leadership that can effectively and persuasively convey a vision will be necessary to meet the knowledge demands of the twenty-first century (Alire and Evans, 2013, p. 342). Library management is increasingly more important than technical processes and challenges with technology adoption and assimilation. One of the hardest things in life is adjusting to change. Libraries and librarians will need to better understand the needs of their users in order to provide them with appropriate information. It will be necessary for librarians to consider learning new skills, collaborating more, and approaching their work from a range of disciplines. The role of libraries will undergo a considerable transformation in the next years as a result of demographic changes, increased urban migration, and technology improvements. Due to resource constraints, libraries will have

to serve more physically crowded and culturally varied communities in the future. Libraries will play a key role in attempts to close the access gap between the rich and the disadvantaged in society in the next decades. They might even be the ones to bring the latter group into the fold (or perhaps eliminate such distinctions) (Shuman, 2001, p. 195).

In addition, future libraries will have to deal with challenges pertaining to technology, digitization, physical space, funding, creating a positive user experience, training new staff skills, collaboration, advocacy, networking, and mission-related concerns. What has been taught and experienced is essentially not the same as the issues that libraries face. Future library challenges need to be conceptualized, thoroughly rethought, and ultimately approached from the outside in rather than the inside out (O'Connor, 2010). Rapid advancements are being made in the field of library and information sciences. Therefore, information professionals need to replace the traditional methods of thinking, organizing, and retrieving information with new methods for delivering information services. Innovations in information technology will undoubtedly affect the services that libraries should provide to their users.

CONCLUSION

Serving a wide range of complex informational, educational, and instructional needs for a diverse clientele, the modern library is a vibrant, customer-focused organization. In addition to providing users with access to technology, libraries will continue to be essential in creating new information systems for the organization, sharing, and preservation of information in any format. Libraries are now one of several nodes that people can utilize to obtain information, rather than being isolated information islands. Since information is a worldwide and universal resource, they are present everywhere and will continue to exist as long as new information is created. To stay up with these changes, they must realign their buildings, services, and collections. By anticipating change and modifying our library and information services to meet the needs of the times, we must create our own future. Therefore, in the digital age, we need to educate people about the value and significance of libraries as public spaces, maker spaces, research labs, and essential democratic institutions. We can ensure that libraries will continue to thrive in the future. As LIS professionals, it is our responsibility to influence the future. There are many exciting opportunities for librarians to develop and implement creative service delivery strategies, enhance learning through the use of technology, and address urgent information preservation and archiving needs. Additionally, librarians will continue to represent information access issues to governments and other decision-making bodies in the larger societal arena. Librarians will continue to invest more resources in technology as the library's reliance on it grows. This is due to the need for adaptability in order to enable the library to mentally and physically switch between various technologies with ease.

The well-known role of librarians in the twenty-first century as information intermediaries needs to change significantly to avoid being supplanted by a variety of content providers. This is demonstrated by the rapid advancements in information and communication technology (ICT) and changes in the economy. Although super highways and highways have been made possible by ICT advancements, very few cars are currently utilizing them. Information providers, promoters, intermediaries, and end users must all change their approaches and increase their ability to embrace new technologies in order to solve the problem. This means that in order to overcome the obstacles that lie ahead, everyone must work extra hard to establish enough trust (Subhashini, 2000). Technology will keep creating new opportunities for libraries to create, arrange, and distribute content, serve new and often distant patrons, and enhance education. Technology will present difficulties for the library as it strives to preserve and offer fair and reasonably priced access to information. The new technologies have played a major role in supporting the development of value-added library services. Libraries will continue to hold physical books in the digital age, but they will also undergo radical transformations as they adapt to offer their users new services enabled by digital technologies.

Libraries will be crucial to the country's future development, particularly in terms of enlightenment in education and society. Given the complexity of modern society and the growing demand for information, more community development-focused initiatives are required to supplement traditional library services in developing countries. Butler (1933) acknowledged the value of libraries to society when he stated that "the library has been created by actual necessities of modern civilization." Since libraries must meet the needs of all types of patrons in all circumstances, the idea behind them is still relevant today. These days, they are essential to society's efforts to bridge knowledge for a sustainable global community. *"Tomorrow's Libraries will have to change their role from Information store house to idea stores, complete with Cafes, Crèches and multimedia offering".* Libraries can become learning centers for innovation. To quote Cohen (1997), who said, "*We are not quite sure what adventures we will have or what we will find, but there will undoubtedly be times of frustration as well as of great excitement".*It can be stated that the future is not predetermined, and we have the ability to shape it ourselves instead of allowing it to be dictated by others. *"No one can predict the future with any real degree of certainty, but it sometimes seems as though everyone is giving it a try. Certainly, the future cannot be predicted accurately, and prediction is not an exact science"*(Shuman, 2001).It is true that LIS professionals have a significant impact on how society is evolving. It is undeniable that the future belongs to those "strong libraries that lead to strong societies," and librarians undoubtedly have the ability to change not just the lives of individuals but also entire communities (Karisiddappa and Ramesh Babu, 2023).

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Beyond the Books – Reimagining Libraries for a Techno-Futuristic World

"The only thing that you absolutely have to know is the location of the library."

– Albert Einstein

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Abstract

Libraries have always been more than mere book repositories. They have continually reinvented themselves as pillars of knowledge and community through the ages. In the digital era, the humble library is transforming into a cutting-edge knowledge hub filled with artificial intelligence tools, digital content studios, maker spaces, and personalized learning systems. This metamorphosis is especially pertinent to academic and legal communities in India, where libraries stand at the crossroads of tradition and innovation. Beyond the Books – Reimagining Libraries for a Techno-Futuristic World explores how these institutions are evolving rapidly, inspiring educators and students alike with their adaptability and enduring mission.

Keywords: Law Library, AI in library, Personalized Learning, Open Access, Virtual Library

INTRODUCTION

Consider this scenario -A law student walks into the campus library. Glass doors slide apart and a small hologram greets the student by name. It has already saved a quiet desk and told a robot arm to fetch the law book the student needs. All around in the library, students use 3D

printers, build small robots, and record podcasts. In the study pod, a smart screen shows the student - their notes, links new court cases, and formats the citations. Later the student joins a virtual debate on data privacy, then relaxes on the rooftop garden. The library guides them through each step, turning study into an easy adventure.

The above scenario is not in the distant future, we could witness this in the next few years.

From the ancient archives of Nalanda and Alexandria to the grand halls of modern universities, libraries have long been revered as sanctuaries of knowledge. Over centuries, they adapted from housing palm-leaf manuscripts and leather-bound tomes to curating microfilms and digital databases. Notably, in 1931, Indian librarian Padma Shri. S. R. Ranganathan formulated the **Five Laws of Library Science** – guiding principles like «Books are for use» and «A library is a growing organism» – highlighting that libraries must be user-centric and ever-evolving. Decades earlier, in 1910, Maharaja **SayajiRaoGaekwad III** of Baroda envisioned libraries as the «people›s *university*," insisting that they serve not just English-speaking elites but readers in every local language. This inclusive, forward-looking ethos has defined libraries throughout history and set the stage for their transformation in the digital age.

MORE THAN BOOKS: LIBRARIES AS COMMUNITY HUBS

A modern public library in the digital era is designed as an open and inviting community space. Modern libraries are **social infrastructure** as much as educational resources. India alone hosts over **54,000 public libraries**, reflecting an extensive network that reaches from megacities to rural villages. Far from silent stack rooms, today's libraries double as community centers – offering free internet to bridge the digital divide, providing training in digital literacy, and even assisting citizens with e-governance services. According to the American Library Association, public libraries in the U.S. has over 17,000 branches, and 80% of Americans say libraries help them find trustworthy information – a testament to the public trust these institutions command. Libraries have also become safe havens: they serve as study spaces for everyone, venues for community meetings and legal aid clinics, and refuges for those seeking a quiet, secure environment. The **COVID-19** pandemic underscored this community role; libraries worldwide expanded online services and outreach, ensuring continuity of learning and access even during lockdowns. In India, grassroots initiatives like the *Free Libraries Network* (FLN) have further championed inclusive access, setting up free community libraries in underserved areas. Clearly, the library›s mission now extends «beyond the books» – it is a dynamic, people-centered hub empowering society through knowledge.

INNOVATING SPACES: MAKERSPACES AND DIGITAL STUDIOS

Automated book retrieval systems, like this robotic "bookBot" in a modern library, exemplify how libraries use technology to manage vast collections efficiently. Walk into a forward-thinking library today, and we might find a **3D printing lab**, a multimedia **digital studio**, or an innovation makerspace where students tinker with robotics and design projects. Libraries are repurposing areas once filled with shelves into collaborative zones for creation and innovation. For example, the North Carolina State University's Hunt Library – touted as a "library of the future" – still houses thousands of books but delivers them via an automated robotic system, freeing space for a creativity studio, gaming lab, recording studios, and a makerspace. In Helsinki, the iconic Oodi Library devotes only one-third of its floor space to books, dedicating the rest to public "living room" areas, makerspaces with 3D printers and a recording studio, and even **book-sorting robots** that manage its collection. Such designs reflect a new philosophy: libraries are active learning environments, not passive warehouses. By providing tools and space for hands-on exploration – be it crafting a prototype, producing a podcast, or developing legal tech solutions – libraries have become incubators of creativity across disciplines.

AI IN LIBRARIES: TOWARDS PERSONALIZED LEARNING

Another frontier in the library's evolution is the integration of **artificial intelligence (AI)**. Academic libraries are leveraging AI to enhance both research and learning experiences. For instance, AI-powered search platforms can easily interpret natural language queries, helping a student or lawyer find relevant scholarly articles or case precedents. Rather than poring over index catalogs, users can ask questions in plain English and get pointed to the right journal, statute, or book. AI also augments library operations behind the scenes: intelligent systems now assist librarians by automating cataloging and digitization (using OCR to scan old manuscripts), managing inventory, and even answering routine queries through chatbots.

Perhaps most exciting is how AI enables **personalized learning**. Libraries should use AI recommendation engines to suggest books, research papers, or online courses tailored to an individual's interests and past reading habits. A law student researching constitutional law might automatically be alerted to new articles or historical judgments relevant to their topic. Some libraries are even experimenting with AI-driven tutoring programs and interactive storytelling sessions, blending library content with adaptive learning software. These innovations promise to transform libraries into not just places to find information but partners in each patron's learning journey.

Of course, embracing AI comes with responsibilities. Ensuring **ethical AI use** and guarding patron privacy are now part of the librarian›s mandate. Algorithms must be monitored so they do not inadvertently reinforce bias or exclude diverse voices. Likewise, libraries are careful that personalization does not compromise user privacy – data on reading habits and queries is kept confidential. In this way, libraries are adopting advanced technology in alignment with their core values of equity and trust. Rather than replacing librarians, AI is freeing them from clerical tasks to focus on higher-order guidance – helping readers navigate the sea of information with a human touch.

THE LAW LIBRARY IN THE DIGITAL AGE

For law faculty and students, these library innovations are not just academic abstractions – they are reshaping legal research and education. Legal scholarship has traditionally relied on vast law libraries stocked with case reporters, statutes, and journals. India's Supreme Court Judges Library, established in 1937, remains one of the largest law libraries in Asia, symbolizing the importance of comprehensive collections. Today, however, much of that collection is accessible at the click of a button through digital databases and archives. Modern law libraries provide online access to court judgments, legislation, and commentary, often through subscription platforms like **Manupatra** and **SCC Online**, as well as open-access portals. For example, the National Digital Library of India now aggregates judicial resources and law journals among its 80+ million educational items, making legal knowledge more accessible to students across the country.

In this digital age, law librarians have become even more crucial as navigators, as they train students to use advanced legal research tools and to critically evaluate online sources for authority and authenticity – a vital skill when misinformation is rife. Many law libraries are creating **digital repositories** of theses, moot court memorials, and research papers, preserving the intellectual output of their institutions for future scholars. Some are even experimenting with AI-assisted legal research tools that can sift through precedents or streamline case law analysis, illustrating how intelligent systems might assist the practice of law. At the same time, law libraries are embracing the collaborative spirit of the modern library: hosting workshops on legal tech, offering spaces for interdisciplinary dialogue (where law meets technology or policy), and ensuring that even as information delivery gets faster, the **ethics and nuances of legal research** are not lost. By adapting to technological change while upholding the rigor of legal scholarship, the law library exemplifies the balance libraries strive for. It remains a quiet cornerstone of the justice system – yet now it offers a digital front door open to any student or researcher with an internet connection, fulfilling the democratic ideal of open access to the law.

CONCLUSION: GUARDIANS OF KNOWLEDGE, CATALYSTS OF INNOVATION

From their storied past to their tech-augmented present, libraries have proven resilient and forward-looking institutions. The **techno-futuristic** library is not a distant fantasy – it is already taking shape in India and worldwide through digital knowledge networks, intelligent research aids, and vibrant community spaces. Yet, in this transformation, libraries hold tight to their core mission: to provide equitable access to knowledge, foster intellectual growth, and preserve the cultural record.

This reimagined library offers inspiration for educators and students – whether in law or any field. It invites us to collaborate across disciplines, harness new tools for deeper learning, and ensure that the pursuit of knowledge remains inclusive. Walking into a library that hosts a holographic exhibit on constitutional history or logging into a virtual library portal that curates personalized resources for our research, one senses the continuum of innovation that connects our generation to scholars centuries ago.

The famous Indian librarian Prof. S. R. Ranganathan envisioned a library as a "growing organism." In a rapidly changing world, libraries continue to grow and change with it—**guardians of knowledge** that light the way forward and **catalysts of innovation** that empower the next generation of learners and leaders.

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AI-Driven Innovations in Libraries: Revolutionizing Cataloguing and Metadata Management

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Abstract

Artificial Intelligence (AI) is revolutionizing the operations and services of the libraries by augmenting cataloguing, classification, and user experience. Traditionally human based manual processes such as cataloguing and metadata generation are now automated with AI-powered tools, which improvesproficiency, accuracy, and consistency. By supporting technologies such as machine learning (ML), natural language processing (NLP), and semantic search, libraries can provide tailored search results, personalized recommendations, and adaptive learning resources. AI-driven systems like Ex Libris Alma, OCLC's WorldCat, and EBSCO Discovery Service integrate seamlessly with existing library management systems, empoweringimproved functionality without requiring complete refurbishments. These advancements enable libraries to manage massive collections effectively while empowering librarians to focus on impactful tasks. As AI continues to evolve, its potential to transform library services and provide personalized user experiences will only grow.

Keywords: Artificial Intelligence (AI), Libraries, Cataloguing, Metadata Generation, Natural Language Processing (NLP), Semantic Search, Personalized Recommendations, Adaptive Learning Resources, Library Management Systems

INTRODUCTION

Artificial Intelligence (AI) is the replica of human intelligence in computers that have been taught to think and learn. Its applications improve user experience, accuracy, and efficiency in a wide range of sectors. In the context of libraries, artificial intelligence (AI) is essential to changing operations and services and making them more effective and user-friendly. In order to keep resources arranged and user-accessible, cataloguing and classification are essential components of library administration. Traditionally, these responsibilities have required careful attention to detail and have been labor-intensive and time-consuming. But as artificial intelligence (AI) advances, libraries are seeing a dramatic change in the way these processes are managed. AI-powered solutions improve the user experience by increasing cataloguing and classifying efficiency, accuracy, and consistency.

AI IN LIBRARIES – AN OVERVIEW

The use of AI in libraries expands the scope of conventional library services. AI makes it easier for libraries to handle enormous volumes of information by automating repetitive processes and offering sophisticated data analytics. AI has the potential to greatly enhance library search capabilities. Finding pertinent materials is made simpler by Natural Language Processing (NLP), which enables users to conduct information searches in conversational language. Additionally, AI is able to comprehend semantics and context, producing more precise and pertinent search results. Based on user interactions, AI can handle difficult questions and improve results, learning and adapting to make future searches better. This feature can greatly cut down on the amount of time patrons spend looking for information, improving their overall library experience. Thus, "Save the reader's time," the fourth law of Dr.S.R.Ranganathan, is proved.

Recent literature highlights the transmuting impact of Artificial Intelligence (AI) on library services, particularly in classification and cataloguing, metadata management, search capabilities, and personalized user services.AI in Libraries: Enhancing Efficiency- Steiger (2024) discusses the dual nature of AI in academic libraries, highlighting its potential to streamline operations and assist in student services, while also cautioning against challenges such as plagiarism and misinformation. Metadata Generation and Management-Subaveerapandiyan (2023) provides a comprehensive review of AI applications in libraries, emphasizing the role of AI in automating metadata generation and improving resource organization.Improving Search Capabilities with AIA systematic literature review by Li et al. (2023) analyzes AI applications in library search systems, noting that AI enhances information retrieval through natural language processing and machine learning techniques. Personalized Recommendations and Adaptive LearningSteiger (2024) also explores how AI can personalize learning experiences in academic

libraries, tailoring resources to individual user needs and thereby enhancing educational outcomes. Responsible AI PracticesSmith (2024) examines AI projects in library and archive settings, emphasizing the importance of ethical considerations and responsible AI practices to mitigate potential risks associated with AI implementation. The above studies cooperatively highlight the significant progressions and reflections in integrating AI into library services, contributing a base for future research and practical applications in the field.

ENHANCING CATALOGUING AND CLASSIFICATION

AI powered Cataloguing systems helps to organise the library resources using less manual effort with minimal efforts. AI generates and handles the metadata efficiently, ensuring accurate and reliable classification. These advancements significantly improve the rapidity, accuracy and efficiency of Cataloguing processes.

AUTOMATED CATALOGUING SYSTEMS

Significant time and cost savings can be achieved by automating the cataloguing and metadata development processes. Compared to manual methods, AI can examine and classify all the materials far more quickly and precisely, ensuring that resources are readily available and searchable. AI-powered automated cataloguing systems are capable of accurately and swiftly processing massive amounts of data. Without human assistance, AI classify objects and identify patterns using machine learning techniques. For example, OCLC's WorldCat develops AI to augment its database for global catalogue of library collections.

AI FOR METADATA GENERATION AND MANAGEMENT

Metadata is playing a vital role for organizing and retrieving information in the modern-day libraries. AI can generate and manage metadata more efficiently than traditional methods. Machine learning models can analyse text, images, and other media to extract relevant metadata, ensuring consistency and accuracy. The following is an example for using this process successfully. Library of Congress has implemented AI tools to augment its metadata generation process by using Natural Language Processing (NLP) algorithms. The library can automatically generate subject headings, classification, acquisitions and cataloguing process. AI for image classification is used in Stanford University library. The AI system has quickly analysed image content then generate accurate metadata and classification, that helps to speed up the cataloguing process in huge collections.

ENHANCING CLASSIFICATION SYSTEMS

AI augments traditional classification systems by providing approximate and vigorous categorization. Machine learning models can identify meticulous differences between each item then allowing to fetch further details and do exact classification. This competence is particularly using to manage large and diverse collections. The British Library hires AI to classify its wide digital collections, using to analyse text and metadata. AI assemblies the similar data in a sole group and deliver comprehensive classification. AI systems has been integrated with existing library management systems, augmenting the functionalities without the necessity of complete revamps. This amalgamation endorses that the libraries can adopt AI technologies without any interrupting the current manoeuvres. Ex Libris Alma is a one of the library management systems that integrates with AI for cataloguing and classification. The features of this system augment metadata management, resource retrieval and improves inclusive library efficiency. Manual cataloguing is prone to human error, that can lead to discrepancies and imprecisions in the library catalogue. AI curtails these errors by providing reliable and exact data processing. This consistency confirms that the users can trust the information provided by the database.

AI-DRIVEN SEARCH ENGINES

Machine Language (ML) and Natural Language Processing (NLP) are used by AI-driven search engines to better comprehend user queries and provide more accurate results. By comprehending the context and intent of the search queries, these technologies allow the search engines to do more than just match keywords. EBSCO Discovery Service is using AI and machine learning (ML) to augment its search capabilities, by analysing the user's queries and their search behaviour. This discovery service can deliver pertinent and significant search results. **NLP Search Engines:** This search engines can comprehend and handle human language in a way that feels natural to users.The ability of NLP algorithms, to decode synonyms, slang, and other phrase patterns, guarantees that the users will get results accurately. Google Scholar hires NLP to understand academic queries and providing appropriate results from articles, theses, books, conference papers and so on. This search engine can differentiate the context of the query and provide results closely with the user's research aim.

Semantic search methods allow one to decrypt the meaning of the words in a query. This knowledge enables the search engine to link related ideas and provide semantically relevant results, even if they don't include the user's exact search phrases. OCLS's WorldCat functions with semantic search engine. This search engine identifies the related terms and notions and provide the users with pertinent and accurate search results.

LIBRARY SERVICES WITH AI TOOLS

Artificial Intelligence tools are transforming the library services by contributing tailor made support which augments the inclusive user experience. Through advanced algorithms and machine learning, AI can comprehend the user needs, and preferences providing customized services significantly. This incorporation services make the library interactions innate, competent and sustaining for the users.

Personalised Recommendations; AI tools explore user data, such as borrowing log history, search queries history, and their reading pattern, to offer personalized recommendations for books, articles and other resources. This service helps the users to discover their preferred materials. ProQuest and EBSCOHOST these two academic databases are using AI algorithms to recommend articles and papers based on the user's earlier search history, confirming that the users find relevant and suitable information rapidly.

Customized Search Results: AI augments search engines to distribute results that are more appropriate to the individual users. The search engines understand the context and purpose after search queries and providing the pertinent results. Google Scholar uses AI to improve the search results created on the user's past searches and their interests, retrieving the highly relevant papers and studies for the researchers.

Adaptive Learning Resources: AI provides adaptive learning resources based on the user's learning pace and style. This tailor-made approach supports the users attain the best learning outcomes based on their needs. Khan Academy customise AI to develop individual learning way for their registered students, teachers and other users, endorsing lessons and workouts based on their performance and development.

CONCLUSION

AI is reforming the cataloguing and classification processes in libraries by providing automated, precise, and effective systems. These advancements not only improve the organization and accessibility of library resources but also empower librarians to focus on more impactful work. As AI technology continues to advance, its potential to transform library services and user experiences will only grow. AI significantly enhances library search engines by providing more relevant and accurate search results through advanced technologies such as natural language processing, semantic search, personalized recommendations, and machine learning. AI tools significantly improve library services by providing tailored support and improving the overall user experience. Through acknowledged recommendations, adaptive learning resources, virtual

assistants, and real-time language translation, AI makes library interactions more instinctive and effective.AI systems can deliver personalized recommendations, search results, notifications, and learning resources. This personalization not only improves user satisfaction and engagement but also makes library resources more accessible and relevant to each individual user. As AI technology continues to evolve, its role in enhancing library services will only grow, further transforming the way libraries operate and serve their communities.

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Common techniques in Artificial Intelligence (AI) Enabled Research Tools

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Abstract

In this article, the authors have studied various AI tools which are available for assisting the research works in detail. It extends from the reference management software, Plagiarism checking software, Summarising and paraphrasing software, Translating and Language enhancing tools, Image Generating tools, Presentation developing tools, Citation databases etc. The features of the software were studied and analysed with a comparative table with their level of access has been estimated and revealed.

INTRODUCTION

Artificial Intelligence is a dominating feature of all the fields in today's technological advancement. In particular, the ever transforming academic field is extensively using this recent technology. The researchers are employing various tools to improve the presentation, for wider acceptance of their research output, to achieve the possible hypotheses, to draft the literature review etc. While examining the features of the research tools enabled with the AI have brought an idea about the leading techniques that simplify the research steps to keep track of this ever growing research publications and their impact on their field of studies. AI provided wider transforming ideas on the area of work, it extends the frontier of the particular knowledge under consideration.

The recent workshops on the AI enabled tools have highlighted the possible ways of utilising them in every walk of the research field in a judicious manner. The scope of this work has developed based on these workshops, testing of the free version of the software, studying the extra features of the subscribed version of the packages.

METHODOLOGY

The packages were sorted based on their scope of dealing especially through the steps of the research methodology like hypothesis generation, improving the language used, reviewing the literature, summarizing the previous research output, paraphrasing, plagiarism checking, developing the required graphical interpretations like charts, diagrams, flowcharts etc. This work invites the possible way of utilising the research tools in developing the research publications in a time saving manner and extending the scope of the study. It has documented the experience of the researchers and the experience of the authors themselves in handling each and every tool discussed in the following section by exploring all the possible features that enable to get the desired outcome. Mostly the free version or basic version of the software were extensively explored and the features mentioned in the subscribed version were also taken into account for this discussion. The ongoing developments in the AI field of technology on a wider span of area of not only academia but also on industrial research were also deeply taken into consideration.

Tools discussed:

- Semantic Scholar
- Iris.ai
- Consensus

- SCISPACE
- Research Rabbit
- PerPlexity
- AI-enabled iThenticate
- Quill Bot

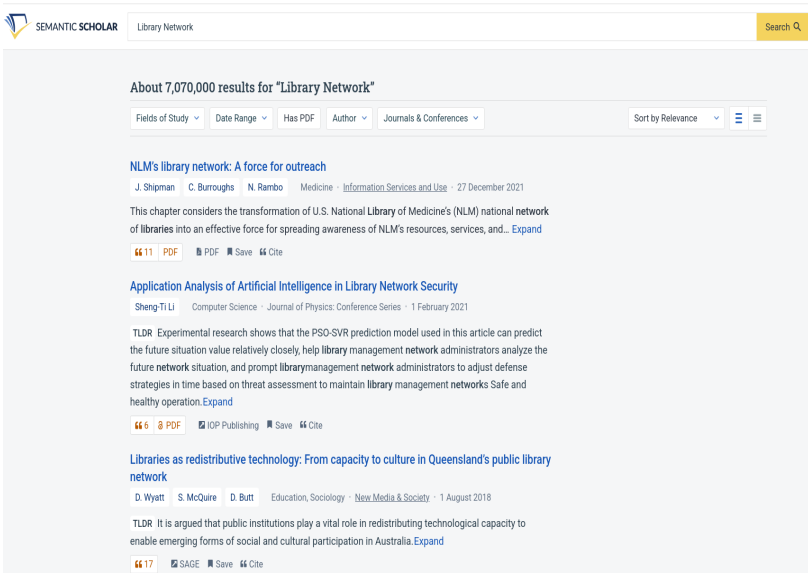

Figure 1

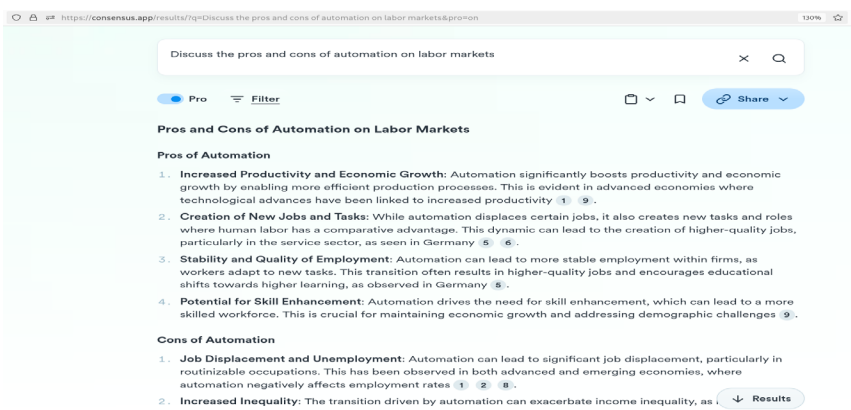

Figure 2

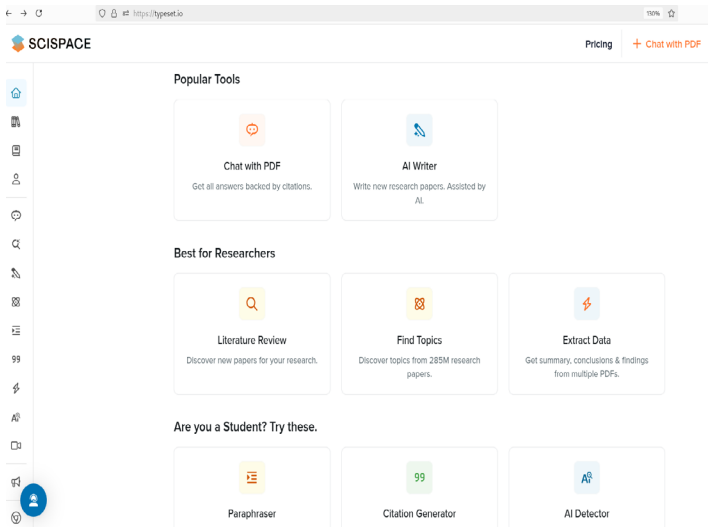

Figure 3

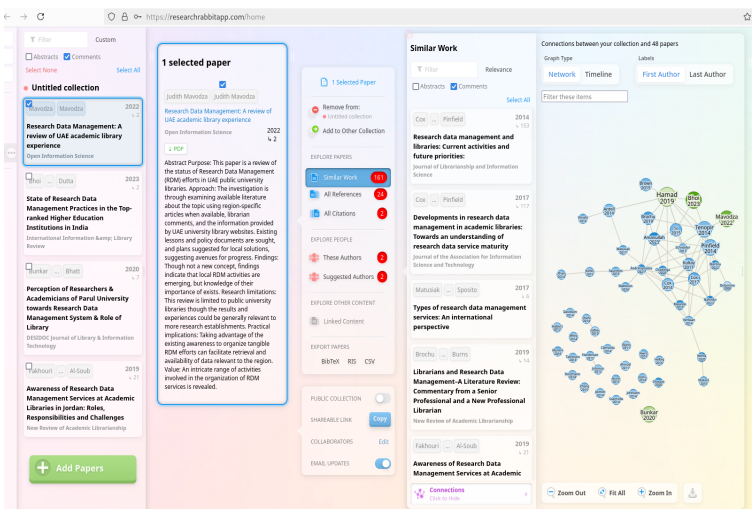

Figure 4

1. **Semantic Scholar**

   Focus: AI-powered research tool for academic literature

   - Citation graphs and analysis (see how papers are connected).
   - Topic-based filtering and exploration of literature.
   - Identification of influential papers in specific fields.

- Automatic summarization of papers (abstracts and conclusions).
- AI-driven recommendations based on your reading history.

2. **Iris.ai**

   Focus: AI for scientific literature and research management

   - Research mapping: Creates a visual overview of relevant literature.
   - Extractive summarization: Highlights key sections of scientific papers.
   - Concept mining: Identifies key topics and themes from texts.
   - Research clustering: Groups related papers based on content and focus.
   - Works with patent databases and technical documents.

3. **Consensus**

   Focus: AI-driven research insights and summaries

   - Semantic search for answering specific research questions.
   - Extracts and synthesizes insights from multiple academic papers.
   - Provides summaries based on academic consensus for a topic.
   - User-friendly, conversational interface for quick queries.
   - Focuses on evidence-based, peer-reviewed content.

4. **SCISPACE**

   Focus: Writing, formatting, and publishing academic papers

   - AI-based paper formatting for thousands of journal styles.
   - Journal selection assistant: Matches your paper to a suitable journal.
   - Research writing assistant: Helps with grammar, structure, and clarity.
   - Automated reference and citation management.
   - Collaboration tools for co-authors and reviewers.
   - Templates and compliance checks for academic guidelines.

5. **Research Rabbit**

   Focus: Visual exploration and discovery of research papers

   - Interactive graphs showing relationships between papers, authors, and topics.
   - AI-powered paper recommendations based on your input.
   - Bookmarking and organizing papers into collections.
   - Alerts for new papers related to your research interests.
   - Easy exploration of author networks and their works.

6. **Perplexity AI**

   Focus: Conversational AI for research and question answering

   - Provides concise, evidence-backed answers to user queries.
   - Sources answers from trusted databases, academic papers, and the web.
   - Ability to link to references for further reading.
   - Handles a wide range of topics, including non-academic queries.
   - User-friendly, chatbot-like interface for real-time Q&A.

7. **AI-enabled iThenticate**

   Focus: Plagiarism detection for academia and publishing

   - Advanced plagiarism detection for scientific and academic documents.
   - Compares text against millions of scholarly articles, books, and web pages.
   - Generates detailed similarity reports with flagged sections.
   - AI capabilities for identifying paraphrased or rewritten content.
   - Compliance with ethical publishing standards.

8. **QuillBot**

   Focus: Writing assistant and text enhancement

   - Paraphrasing tool: Rewrites text while preserving meaning.
   - Summarizer: Condenses large texts into concise summaries.
   - Grammar and spell check.
   - Plagiarism checker (premium feature).
   - Citation generator for research writing.
   - AI writing styles (formal, casual, creative, etc.).

COMPARISON OF FEATURES:

1. AI-Driven Insights and Recommendations
   - Most tools leverage **AI algorithms** to analyze data and provide relevant insights or recommendations, such as:
     - Semantic Scholar, Iris.ai, and Consensus: Suggest relevant research papers and summarize findings.
     - SCISPACE and Research Rabbit: Recommend related papers, journals, or topics.

2. Summarization and Simplification
    - Several tools summarize complex information into digestible formats:
        - **Consensus, Semantic Scholar, and Iris.ai**: Summarize academic papers and extract key points.
        - **QuillBot**: Summarizes lengthy text into concise versions.
        - **Perplexity AI**: Provides quick, conversational summaries of user queries.
3. Text Analysis and Refinement
    - Advanced text analysis and enhancement capabilities:
        - **QuillBot**: Offers paraphrasing, grammar checking, and writing style improvements.
        - **AI-enabled iThenticate**: Detects plagiarism and ensures originality.
        - **SCISPACE**: Enhances writing quality and ensures adherence to journal standards.
4. Search and Discovery
    - Powerful search and discovery engines:
        - Semantic Scholar, Iris.ai, Research Rabbit: Help discover related literature and visualize connections between research topics.
        - Consensus and Perplexity AI: Act as conversational search engines for research-based questions

Table 1

Tool	Primary Focus	Key Features	Target Users	Unique Selling Point
Semantic Scholar	Research and Literature Discovery	Citation graphs, topic-based filtering, influential paper identification, AI recommendations	Academics, Researchers	AI-powered analysis of scholarly connections and influential works
Iris.ai	Scientific Literature Navigation	Research mapping, extractive summarization, concept mining, research clustering	Researchers, Innovators	Visualizing and summarizing scientific research

Tool	Primary Focus	Key Features	Target Users	Unique Selling Point
Consensus	Research Summarization	Semantic search, academic consensus summaries, evidence-backed insights	Academics, General Users	Summarizes scientific consensus for specific research questions
SCISPACE	Research Writing and Publishing	AI formatting, journal selector, collaboration tools, reference management	Researchers, Authors	End-to-end AI assistance for academic paper writing and publishing
Research Rabbit	Visual Research Exploration	Interactive graphs, paper recommendations, author networks, alerts for new papers	Researchers, Students	Visual exploration of research connections and author relationships
Perplexity AI	Conversational AI for Research	Evidence-backed Q&A, trusted database sources, real-time responses	General Users, Students	Conversational AI with reliable references for research-based answers
AI-enabled iThenticate	Plagiarism Detection	Advanced plagiarism detection, similarity reports, AI for paraphrasing detection	Academics, Publishers	Industry-standard plagiarism detection with AI enhancements
QuillBot	Writing Assistant	Paraphrasing, summarization, grammar check, citation generator	Writers, Students, Academics	Multi-functional AI writing assistant for improving clarity and style

Key Observations:

- **Target Users Vary**: Tools like **Semantic Scholar** and **Iris.ai** are focused on academics and researchers, while tool like **QuillBot** serve broader audiences, including writers and businesses.
- **Unique Strengths**:
  - **Consensus** is great for summarizing academic consensus.
  - **Research Rabbit** excels in visualizing relationships between research topics and authors.
  - **SCISPACE** is ideal for formatting and publishing research papers.
- **Plagiarism and Originality: AI-enabled iThenticate** stands out for its plagiarism detection tailored for publishing.

GENERAL OBSERVATIONS

- Large data were simply handled with all possible minute features using the AI technology. The frequently used data fields can be easily identified using the AI tools and without spending much time on the framing of the data collecting process for the requested research area. Without getting the feeling of missing of any repeatable but essential data collection fields. It enables to provide time on structuring the complex systems of one's research data collection.
- Algorithm enabled paraphrasing of the uploaded documents is possible to avoid the plagirism.
- The hidden patterns of the unexplored data sets can be established using the AI features enbaled tools. It identifies the potential areas, lateral patterns and helps to fill the research gap by analysing the existing data of the research.
- Possible outcome of the trends with interdisciplinary application with wider techniques on the data will be possible. The undiscovered and unpredictable models can be deisgned using the AI enabled predictive analysis techniques.
- Machine language, natural language enabled AI tools of research activities helps in quicker action, thus saves time and helps to structure the queries easily without any barrier of expression and signal transmission in the related area of research where the transmissions plays a major role.
- Summarising the literature in logical way of reviewing them across the database.

- Drafting the charts, graphical representation in different angle of the researcher's choice to represent the analysis part in clear manner.
- Make the usual task done in automatic way by transforming the huge data into the prescribed set of tables or incorporating into the automated lab/virtual lab. AI tool of virtual lab helps to generate the effective research output.
- It uses ontology based search across its interlinked database, thus matching the natural language search query with the machine understanding. It help to handle the huge data set effectively and efficiently.
- Research Libraries can subscribe to any standard version of the AI enable research tools and provide access to their researchers for augmenting the work.
- Automated harvesting of the data from the huge database or from web server data were using AI extensively for retrieving the retracted articles, through keyword search, COUNTER based usage statistics, highly impacted articles etc.

CONCLUSION

The comparison highlights that AI tools like **Semantic Scholar**, **Iris.ai**, **Consensus**, **SCISPACE**, **Research Rabbit**, **Perplexity**, **AI-enabled iThenticate** and **QuillBot** serve unique purposes thus complementing in research writing, and communication.

- **Academic Research**: Tools such as **Semantic Scholar**, **Iris.ai**, and **Research Rabbit** are inevitable for exploring, discovering, and visualizing connections in scholarly literature. It help the researcher to find the possible connected literatures
- **Writing and Publishing**: **SCISPACE** and **QuillBot** provide excellent support for improving writing, formatting research papers, and meeting journal standards, while **AI-enabled iThenticate** ensures originality.
- **Quick Insights**: **Consensus** and **Perplexity AI** are perfect for answering research-based queries and summarizing academic consensus.

Each tool brings unique strengths, making them valuable for different phases of research, writing, or engagement. Selecting the right one depends on your specific needs, such as conducting research, enhancing writing, ensuring originality, or interacting with users.

AI provides new approaches, unlocks the undetermined ways of scopes on repeatable processes. Its growth will certainly have positive and negative impact on the academic and industrial research outputs.

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Unveiling the Impact of Website Quality on Rankings of National Law Universities in India: A Webometrics Approach

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Abstract

This study made an attempt to unveil the website quality of National Law Universities (NLUs) and its impact on ranking systems of webometrics at international and NIRF at national level. It evaluates the websites of NLUs based on real-world user experience which includes website performance, accessibility, best practices and SEO by Google PSI (Page Speed Insight) metrics. By comparing and correlating these rankings, the study aims to uncover a potential connection between a well- designed website and overall ranking of NLUs. It revealed that NLUs websites need significant improvement in various aspects of user experience. 50% of the NLUs followed best practices to a good extent. However, SEO remains a major weakness, with 87.5% of NLUs needing improvement. The study found no NLUs website that consistently excelled in all audits. It shows that the prestigious national law universities in India are ineffective in the information era because oflack of rationalefor their web policy. By focusing on these areas, they can considerably enhance real-world user experience, increase accessibility of information for all stakeholders and strengthen their digital presence and communication in the digital era**.**

Keywords: Webometrics; NIRF Ranking; Search Engine Optimizer; Legal educational institutions; national law universities; Website quality

INTRODUCTION

A remarkable revolution in the information era marks a seismological shift in human history. It is powered by innovations, diffused and adopted by the society triggering changes in every sphere of human life. The technological innovations particularly internet has significantly changing the educational landscape, transforming the curricula, revolutionizing the pedagogy and democratizing the education. The online tools and platforms provide new learning opportunities for both learners and teachers and remove the physical boundaries in a single mouse click. Universities are the pinnacle of educational institutions restructured themselves to face the challenges and opportunities presented by the ever-evolving digital landscape, to shape the student community, to equip with the skills and knowledge required to survive in the digital economy. A website for a university is not merely a digital brochure or virtual gateway but it is a robust tool to disseminate academic, admission information; to integrate research communities, alumni and exhibits student potentials, faculties expedites. Analyzing the website of universities provide insights about their web presence and visibility. Webometrics offers several indicators / metrics to evaluate the website quantitatively and qualitatively. It furnishes data driven decisions for the stakeholders to identify best practices, create quality backlinks, enrich user experience, and improve content for search engines.

However, the quality of education provided by the universities are not only determined by their web presence and visibility but also research output, student outcomes, teaching learning practices, resources, outreach programs and many more factors. Hence this study made an attempt to unveil the website quality of NLUsand its impact on ranking systems of webometrics at international and NIRF at national level.

Legal education is *sine qua non* for a democratic society as it is based on justice, equality, and legal consciousness. It is essential to instils quality of legal education among law students as they become a good law abiding citizens, legislators, jurists, judges, advocates, policy makers, legal scientist, and social activists in a welfare state. The present legal education system evolved from the passing of Advocates Act 1961. Under the section of S.7 (h), S.7 (i), S.49 (d) and S.24 (1) of advocates act conferred power to Bar council of India to promote legal education, to prescribe standards of legal education and to recognize law degrees for enrolment of persons as Advocates[1]. The legal educational institutions are regulated by University Grant Commission as well as Bar Council of India.

At present there are three categories of institutions imparting legal education in India. 1600 law colleges affiliated to universities funded either by government or private, nearly 250 law departments in the universities, and 26 NLUs, which were aimed at being institutions of excellence [2]. The first and foremost national law school was established in 1986 under

the National Law School (NLS) of India Act (Karnataka Act, 22 of 1986) sponsored by Bar Council of India BCI to achieve excellence in professional legal education. The success of the model National Law School NLS in Bangalore has led to 25 more NLUs across the country.

Webometrics evolved as a scientific field from the pioneering study of Almind and Ingwerson [3] in the year 1997 by applying the techniques of bibliometrics, scientometrics and informetrics to analyse the structure and content of the web. Further studies by Björneborn&Ingwersen [4], Thelwall, [5]proposed a theoretical framework for webometrics which includes analysis of web content, link structure, usage analysis and web technologies.Nawaz et al. [6],Waheed et al. [7] supplemented it.

It is evinced that enormous research has been carried out to assess the web presence and visibility of academic institutions at worldwide [8,9,10,11]. An abundant literature has also been survived on Indian academic institutions. The websites of Institute of Eminence – IITs, IIMs, CSIRlabs[12, 13, 14] higher education institutions [15,16,17,18] are quantitatively analysed by webometrics indicators such as web impact factors, WISER, domain and authority scores, link analysis, back link analysis, keyword analysis through Search Engine Optimization (SEO) tools like Ahrefs, Alexa, Semrush for their web presence and visibility. There are meagre literatures limited to webometrics analysis of libraries of legal educational institutions in India [19, 20]. Abhishek Yadav et al [21] evaluated 23 national law universities in India by Google Rank, Alexa page rank and rich files. However, lacuna is found that there were scant study focuses on applying the webometrics indicators to assess the web presence and visibility of National Law Schools of India which are treated as IITs in legal education.

Due to the characteristic of web dynamism, various indicators / metrics have emerged to assess website presence and visibility. This study aims to quantify the real-world user experience while browsing the websites of NLUs in India using PageSpeed Insights (PSI). It also focuses the impact of website quality on ranking systems, and proposes measures to enhance visibility and presence within the academic web domain.

OBJECTIVES

The core objective of this research is to evaluate the websites quality of NLUs in India and its impact on different ranking systems. In particular, the aims are,

- To evaluate the website performance, accessibility, SEO, and best practices of the
- NLUs of India;

- To analysis the real-world user experience in browsing the websites of National Law Universities of India in terms of Core Web Vitals (CWV) metrics provided by PageSpeed Insights;
- To find out ranking of the NLUs by NIRF, Webometrics, and PSI;
- To compare and correlate the ranking of NIRF, Webometrics and PageSpeed Insights and
- To study the effects of websites quality on ranking systems.

SCOPE AND METHODOLOGY

The research framework used in this study mainly pertaining to the evaluation of objective website quality method which employs webometrics analysis tools and techniques. The population of research consists of 26 Indian national law universities. This research deployed open sources webometrics tool - PageSpeed Insights, provided by Google to evaluate the quality of website in terms of Performance, Accessibility, Best Practices and SEO in a simulated environment. PSI calculates website performance using a lighthouse scoring system ranging from 0 to 100. 0 to 49 indicates poor, 50 to 89 indicate Needs improvements and 90 to 100 stands for a good user experience.

Performance Audit: it ensures that web page is optimized for users to navigate easily and user friendly. A set of metrics are used to calculate the speed and user experience of a web page such as, First Contentful Paint (FCP) measures the duration taken to appear first piece of content; Largest Contentful Paint (LCP) computes the time taken to display largest piece of content; Speed Index (SI) calculates time taken to display visually to the end user; Time to Interactive evaluates the duration of the web page become fully interactive and Total Blocking Time (TBT) determines the time taken to block the main thread by long tasks that prevent user input.

Accessibility Audit: enables to access the content of the web page regardless of any impairments of the user. This study limited to automatic detection of accessibility issues rather than manual testing.

Best Practices Audit: it ensures the fastness, security compliance, and avoids deprecated technologies. It establishes a good user experience by display responsive images with correct aspect ratio and eliminate trigger quirks mode in older browser.

SEO Audits: Search Engine Optimization is a comprehensive evaluation of technical infrastructure, content and on-page elements, backlink profile, of the website. It is conducted

to identify any lapse in technical configuration, weaknesses that prevent the search engines to crawl and index the website.

Many studies [22, 23, 24]used questionnaire as a data collection method for evaluating the user experience about quality of the website subjectively. However in this study, user experiences are objectively measured in the real-world user experience using the Core Web Vitals (CWV). It offers stable, experimental, and pending metrics to assess the quality of user experiences in website utility. This study exploited stable metrics Largest Contentful Paint (LCP), First Input Delay (FID), and Cumulative Layout Shift (CLS), which are primarily used to assess a website's loading performance, interactivity, and visual stability. These stable metrics are considered essential for a great user experience. Table1 exhibits the threshold values for the stable metrics to ensure a good user experience.

Table1. Core Web Vitals: Threshold Values

S. No	CWV	Thresholds			Page Loads
		Good	**Need Improvements**	**Poor**	
1	LCP	<= 2.5 seconds (89%)	2.5 - 4 seconds (5%)	> 4 seconds (6%)	Duration of the page first start to load
2	FID	<=100 ms (100%)	100 ms - 300ms (0%)	>300 ms (0%)	Duration of a user first interact with a page by clicking a link or tap a button etc.., and its responsive time
3	CLS	<=0.1 (96%)	0.1 -0.25 (3%)	>0.25 (1%)	When the largest burst of layout shift scores for every unexpected layout shift that occurs during the entire life span of a page.

The CWV assessment for a website is passed either the 75th percentiles of all three metrics are good or the 75th percentiles of LCP & CLS are good with sufficient data aggregated at the page or original level. This study excludes Dr. B.R. Ambedkar National Law University and Tamil Nadu National Law University from CWV assessment due to insufficient real-world speed data and invalidity of the websites.

The NLUs are ranked according to the scores secured for performance, accessibility Best Practices, and SEO by PSI. In addition, Webometrics & NIRF Ranking for 26 NLU is computed to study the effects of websites quality.

Webometrics [25] is the ranking system developed by the Cybermetrics Lab offers ranking for every six months that evaluate the performance of higher education institutions worldwide based on their web presence and impact. The webometrics current edition Universities, July 2023.2.2 used for ranking the NLUs. Particularly the country ranking is taken into consideration as the study population is at national level. Webometrics ranking is not available for the four national law universities namely Dr. B.R. Ambedkar National Law University (DBRANLU), National Law University Tripura (NLUT), Gujarat National Law University, Silvassa Campus (GNLUS), National Law University Meghalaya (NLUM).

Ministry of Education, Government of India adopted a ranking methodology called National Institutional Ranking Framework (NIRF) [26] to rank institutions of higher education in India. NIRF proposed a separate methodological framework for ranking the legal educational institutions as Teaching, Learning & Resources (0.40), Research and Professional Practice (0.15), Graduation Outcomes (0.25), Outreach and Inclusivity (0.10), Perception (0.10).

This study utilized non-parametric measure Spearman's rank order correlation co-efficient to correlates and compares the ranking of NIRF, Webometrics and PSI for 11 NLUs by following formula,

$$\rho = 1 - 6\Sigma d^2/n(n^2 - 1)$$

Where: ρ is the Spearman rank-order correlation coefficient

Σd^2 is the sum of the squared differences between the ranks of the two variables

n is the number of observations. When p = 0 there is no association between the variables; p= +1 denotes perfect positive and p = -1 denotes negative association between the variables.

The hypothesis "**H_o = There is no significant association between the ranking of NIRF, Webometrics and PSI"** drawn to validate the effects of websites quality on ranking system

DATA ANALYSIS AND FINDINGS

Website Performance, Accessibility, SEO, and Best Practices:figure 1 elucidates the metrics of PSI. Totally 24 websites of NLUs are assessed for their performance, accessibility, SEO and best practices. TNNLU and MNLUN are excluded from the study due to errors encountered during the evaluation process. The performance score is a weighted average of the FCP, SI, LCP, TBT, and CLS. It reveals that a significant percentage (54%) of NLUs scored in the **"Needs Improvement"** range (between 52 and 88). This indicates that their websites might function adequatelybut even more faster and user-friendly can be achieved by optimization. An additional **42%** of NLUs scored even lower, falling into the **"Poor"** category (below 52). These websites likely suffer from long loading times, which can be frustrating for visitors.The newest NLUM stands out with a website that performs well, achieving a score of 96. The lowest performance audit score is achieved by NLIU (15) followed by WBNUJS (27), MNLUA (32), MNLUM (33), DNLU (37), and NLUT (38). Accessibility audit are calculated on a weighted scale from 1 to 10. Audits with higher weights have a greater impact on the overall accessibility score. The three NLUs (NLSIU, NUSRL and GNLUS) demonstrated a strong commitment to user accessibility. NLUJ (27), NLUD (45) and DNLU (47) scored the lowest in accessibility audits. 75% of NLUs have the accessibility scores ranges from 65 to 88 suggest that areas for improvement to ensure their websites are accessible to all users.

The PSI ranking shows that no NLUs achieved a good score (100) either in performance or accessibility audits.The Lighthouse Best Practices score treats **every individual audit** within the category with **equal importance**. The best practices audit scores of 50% of NLUs is good suggest that their website adhere to best practices to a great extent. However, a significant percentage (46%) of NLUs scored in the "Needs Improvement" range for Best Practices. This means their websites could benefit from following best practices more closely to enhance user experience.Among the NLUs evaluated, WBNUJS received the lowest score of 45 in the Best Practices audit. They must address some key best practices like secure connections (HTTPS), proper**HTMLdocument type declaration**, and preventing browsers from entering a less-compatible quirks mode. The SEO analysis revealed that the majority of NLUs (**87.5%**) require improvement in search engine optimization.**Prestigious universities, with their long history and established reputation, might not prioritize SEO in their online strategy. They might view it as a more traditional marketing tactic or even something better suited for promoting products rather than the broader value of education.**12.50% of NLUs performed well in SEO, achieving scores that indicate strong optimization practices. Interestingly, no NLUs scored in the very poor SEO range (0 to 50). This might be due to the nature of educational institution websites, which tend to have a baseline level of SEO due to their content and domain authority.

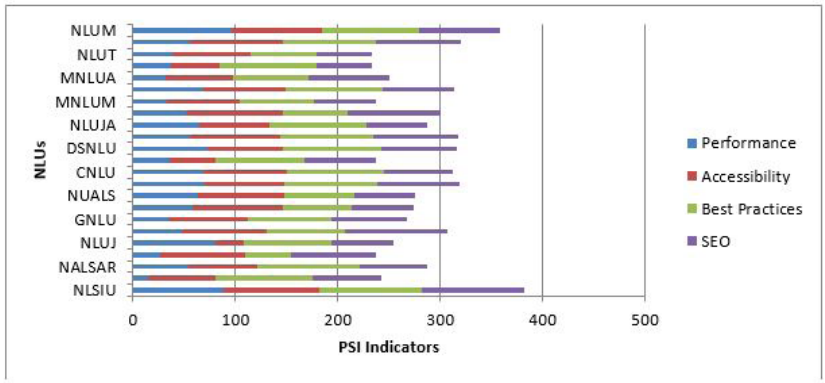

Figure 1 Website performance, accessibility, SEO, and best practices of NLUs

Core Web Vital Assessment: The assessment of CWV for NLUs in India indicates that 15.4 % of the institutions complies the required standards of 75th percentiles of LCP & CLS are good. While five NLUs (NLUJ, NUALS, NLUD, MNLUM, DNLU) achieved good LCP scores, because of their CLS scores (<=0.1) could not pass the CWV assessments. Similarly, WBNUJS, NLUO obtained good CLS (<-0.1) but due to poor LCP thresholds (>4s) unable to pass the CWV criteria. It's noteworthy that all NLUs have obtained good FID thresholds. The table 2 indicates that 42.30% of NLUs need improvement in the time it takes to load their URLs. 15.3% of NLUs' URL exhibit poor user experience due to extended loading times for large content elements like image, video or block level text elements. 46.1% of NLUs gives poor user experience while browsing their web pages. Thus visitors of the web pages often encounter unexpected layout shifts resulting in sudden text movement or unintentional clicks on unwanted links.

Table 2. Core Web Vitals Assessment for NLUs

S. No	National Law Schools	LCP	FID	CLS	CWVA
1	National Law School of India University (NLSIU)	1.3s	2ms	0	PASSED
2	National Law Institute University (NLIU)	5.6s	5ms	0.41	FAILED
3	National Academy of Legal Studies and Research (NALSAR)	2.8s	2ms	0.31	FAILED

S. No	National Law Schools	LCP	FID	CLS	CWVA
4	West Bengal National University of Juridical Sciences (WBNUJS)	5.1s	3ms	0.03	FAILED
5	National Law University Jodhpur (NLUJ)	2.2S	2 ms	0.19	FAILED
6	Hidayatullah National Law University (HNLU)	2.7s	4ms	0.64	FAILED
7	Gujarat National Law University (GNLU)	3.5s	3ms	0.57S	FAILED
8	Dr. Ram Manohar Lohiya National Law University (RMLNLU)	2.8s	2ms	0.29	FAILED
9	National University of Advanced Legal Studies (NUALS)	1.8s	2ms	0.2	FAILED
10	Rajiv Gandhi National University of Law (RGNUL)	2.3s	2ms	0.08	PASSED
11	Chanakya National Law University (CNLU)	3.3s	7ms	0.17	FAILED
12	National Law University Delhi (NLUD)	1.9s	3ms	1	FAILED
13	DamodaramSanjivayya National Law University (DSNLU)	2.9s	2ms	0.63	FAILED
14	National Law University Odisha (NLUO)	6.6s	8ms	0	FAILED
15	National Law University and Judicial Academy (NLUJA)	2s	2ms	0.05	PASSED
16	National University of Study and Research in Law (NUSRL)	3.3s	4ms	0.17	FAILED
17	Tamil Nadu National Law University (TNNLU)	NA	NA	NA	ERROR

S. No	National Law Schools	LCP	FID	CLS	CWVA
18	Maharashtra National Law University Mumbai (MNLUM)	1.4s	2ms	0.57	FAILED
19	Maharashtra National Law University Nagpur (MNLUN)	2.7s	2ms	0	FAILED
20	Himachal Pradesh National Law University (HPNLU)	3s	2ms	0.32	FAILED
21	Maharashtra National Law University, Aurangabad (MNLUA)	3.7s	5ms	0.64	FAILED
22	Dharmashastra National Law University (DNLU)	2.5s	3ms	0.26	FAILED
23	Dr. B.R. Ambedkar National Law University (DBRANLU)	NA	NA	NA	NA
24	National Law University Tripura (NLUT)	2.8s	3ms	0.34	FAILED
25	Gujarat National Law University, Silvassa Campus (GNLUS)	5.1s	2ms	0.15	FAILED
26	National Law University Meghalaya (NLUM)	2.2s	1ms	0.01	PASSED

Rankings of NLUs: The table3 exhibits the ranking of the NLUs based on NIRF, Webometrics and PSI criteria. The NLUs are arranged chronologically from the year they started their academic session.

Table3. Ranking of NLUs

S. NO	National Law Schools	Domain	NIRF	Webometrics Ranking	PSI
1	National Law School of India University (NLSIU) (1986)	https://www.nls.ac.in/	80.52 (1)	344	382 (1)
2	National Law Institute University (NLIU) (1997)	https://nliu.ac.in/	54.68 (6)	884	242 (17)
3	National Academy of LegalStudies and Research (NALSAR)(1998)	https://www.nalsar.ac.in/	73.76 (3)	438	288 (11)
4	West Bengal National University of Juridical Sciences (WBNUJS) (1999)	https://www.nujs.edu/	69.34 (4)	353	237 (18)
5	National Law University Jodhpur (NLUJ) (1999)	https://nlujodhpur.ac.in/	46.6 (10)	928	254 (15)
6	Hidayatullah National Law University (HNLU) (2003)	https://hnlu.ac.in/	NA	945	307 (9)
7	Gujarat National Law University (GNLU) (2003)	https://www.gnlu.ac.in/	65.69 (5)	789	267 (14)
8	Dr. Ram Manohar Lohiya National Law University (RMLNLU)(2005)	http://www.rmlnlu.ac.in/	50.9 (8)	1125	274 (13)
9	National University of Advanced Legal Studies (NUALS)(2005)	https://www.nuals.ac.in/	NA	939	276 (12)
10	Rajiv Gandhi National University of Law (RGNUL)(2006)	https://www.rgnul.ac.in/	51.53 (7)	1036	319 (4)

S. NO	National Law Schools	Domain	NIRF	Webometrics Ranking	PSI
11	Chanakya National Law University (CNLU)(2006)	https://cnlu.ac.in/	NA	1028	312 (8)
12	National Law University Delhi (NLUD)(2008)	https://nludelhi.ac.in/	73.91 (2)	531	237 (18)
13	Damodaram Sanjivayya National Law University (DSNLU)(2008)	https://dsnlu.ac.in/	NA	1357	317 (6)
14	National Law University Odisha (NLUO) (2009)	https://www.nluo.ac.in/	46.02 (11)	966	318 (5)
15	National Law University and Judicial Academy (NLUJA) (2009)	https://www.nluassam.ac.in/	NA	1050	288 (11)
16	National University of Study and Research in Law (NUSRL)(2010)	http://www.nusrlranchi.ac.in/	48.2 (9)	1157	301 (10)
17	Tamil Nadu National Law University (TNNLU)(2012)	https://www.tnnlu.ac.in/	NA	1670	NA
18	Maharashtra National Law University Mumbai (MNLUM)(2014)	https://mnlumumbai.edu.in/	NA	1403	237 (18)

S. NO	National Law Schools	Domain	NIRF	Webometrics Ranking	PSI
19	Maharashtra National Law University Nagpur (MNLUN) (2016)	https://www.nlunagpur.ac.in/	NA	1416	Error
20	Himachal Pradesh National Law University (HPNLU) (2016)	https://www.hpnlu.ac.in/	NA	1425	314 (7)
21	Maharashtra National Law University, Aurangabad (MNLUA)(2017)	https://www.mnlua.ac.in/	NA	2013	251 (16)
22	Dharmashastra National Law University (DNLU) (2018)	https://www.mpdnlu.ac.in/	NA	2056	234 (19)
23	Dr. B.R. Ambedkar National Law University (DBRANLU) (2019)	http://www.dbranlu.ac.in	NA	NA	251 (16)
24	National Law University Tripura (NLUT) (2022)	https://nlutripura.ac.in/	NA	NA	234 (19)
25	Gujarat National Law University, Silvassa Campus (GNLUS) (2023)	https://www.gnlus.ac.in/	NA	NA	320 (3)
26	National Law University Meghalaya (NLUM) (2023)	https://www.nlumeg.ac.in/	NA	NA	359 (2)

Out of 30 legal educational institutions (Table 4) which include private law universities, government colleges, and state universities, NLUs, IITs deplorably 11 NLUs participated in the NIRF ranking.

Table4 NIRF Indian Ranking 2023: LAW

Rank	Name of the Institutions	Place	Score
1	National Law School of India University	Bengaluru	80.52
2	National Law University	New Delhi	73.91
3	Nalsar University of Law	Hyderabad	73.76
4	The West Bengal National University of Juridical Sciences	Kolkata	69.34
5	JamiaMilliaIslamia,New Delhi	New Delhi	68.30
6	Symbiosis Law School	Pune	66.67
7	Gujarat National Law University	Gandhinagar	65.69
8	Siksha `O` Anusandhan	Bhubaneswar	64.04
9	Indian Institute of Technology Kharagpur	Kharagpur	62.20
10	BabashebBhimrao Ambedkar University	Lucknow	61.05
11	Saveetha Institute of Medical and Technical Sciences	Chennai	59.37
12	Kalinga Institute of Industrial Technology	Bhubaneswar	59.20
13	Christ University	Bengaluru	57.78
14	Aligarh Muslim University	Aligarh	56.51
15	Shanmugha Arts Science Technology & Research Academy	Thanjavur	56.37
16	Lovely Professional University	Phagwara	55.41
17	Indian Law Institute	New Delhi	55.34
18	National Law Institute University, Bhopal	Bhopal	54.68

19	Guru Gobind Singh Indraprastha University	New Delhi	54.13
20	The Rajiv Gandhi National University of Law, Patiala	Patiala	51.53
21	Dr. Ram Manohar Lohiya National Law University, Lucknow	Lucknow	50.90
22	Banaras Hindu University	Varanasi	50.18
23	Amity University Haryana, Gurgaon	Gurugram	49.55
24	National University of Study & Research in Law	Ranchi	48.20
25	Alliance University	Bengaluru	48.13
26	Army Institute of Law, Sector-68	Mohali	47.65
27	Nirma University	Ahmedabad	47.57
28	National Law University and Judicial Academy	Kamrup	46.60
29	Manipal University Jaipur	Jaipur	46.54
30	National Law University	Cuttack	46.02

Source: https://www.nirfindia.org/2023/LawRanking.html

It is considered that the four newest NLUs (DBRANLU, NLUT, GNLUS and NLUM) are not participated in the NIRF and webometrics ranking. However, the newest NLUM and GNLUS occupied second and third position in PSI ranking. NALSAR and NLUSA are tied for 11th place. Similarly, 16th place is shared by MNLUA and DBRANLU, while WBNUJS, NLUD, and MNLUM all share 18th position. 84.6%, 92.3% of NLUs are ranked by webometrics and PSI criteria respectively. It is found that the NLUs are realized the importance of web presence as it performs like virtual gateway. NLSIU is an exemplar for other NLUs consistently occupies first place in all ranking systems. NLUD, NALSAR, WENUJS, and GNLU secured high in NIRF (ranking 2nd, 3rd, 4th and 5th respectively) and webometrics (ranking 4th, 3rd, 2nd and 5th respectively). On the contrary, their PSI ranking are considerably lower (18th, 11th, 18th, and 14th). Interestingly, the non-participated NIRF ranking NLUs are positioned competitively ranges 1028th to 2056thin webometrics ranking. Noteworthy that HNLU and NUALS achieved more impressive results securing 939th and 945thpositions in

webometrics. Similarly, 47% of non-participated NIRF ranking NLUs are inferior in PSI ranking ranges 11th to 19th positions. In the PSI ranking DSNLU outranked in 6th position followed by HPNLU (7th), CNLU (8th) and HNLU (9th)respectively.

Table 5. Webometrics Ranking of NLUs

S. No	Name of the NLUs	Country*	Impact*	Openness*	Excellence*
1	National Law School of India University (NLSIU)	344	5532	6258	6598
2	National Law Institute University (NLIU)	884	9418	8183	7237
3	National Academy of Legal Studies and Research (NALSAR)	438	5301	7174	7237
4	West Bengal National University of Juridical Sciences (WBNUJS)	353	7800	6929	6291
5	National Law University Jodhpur (NLUJ)	928	9814	8183	7237
6	Hidayatullah National Law University (HNLU)	945	10060	8183	7237
7	Gujarat National Law University (GNLU)	789	8174	8183	7237
8	Dr. Ram Manohar Lohiya National Law University (RMLNLU)	1125	11910	8183	7237

S. No	Name of the NLUs	Country*	Impact*	Openness*	Excellence*
9	National University of Advanced Legal Studies (NUALS)	939	10023	8183	7237
10	Rajiv Gandhi National University of Law (RGNUL)	1036	11120	8183	7237
11	Chanakya National Law University (CNLU)	1028	11013	8183	7237
12	National Law University Delhi (NLUD)	531	6163	7715	7237
13	DamodaramSanjivayya National Law University (DSNLU)	1357	13728	8183	7237
14	National Law University Odisha (NLUO)	966	10316	8183	7237
15	National Law University and Judicial Academy (NLUJA)	1050	11232	8183	7237
16	National University of Study and Research in Law (NUSRL)	1157	12195	8183	7237
17	Tamil Nadu National Law University (TNNLU)	1670	15901	8183	7237

S. No	Name of the NLUs	Country*	Impact*	Openness*	Excellence*
18	Maharashtra National Law University Mumbai (MNLUM)	1403	14044	8183	7237
19	Maharashtra National Law University Nagpur (MNLUN)	1416	14148	8183	7237
20	Himachal Pradesh National Law University (HPNLU)	1425	14239	8183	7237
21	Maharashtra National Law University, Aurangabad (MNLUA)	2013	18182	8183	7237
22	Dharmashastra National Law University (DNLU)	2056	18487	8183	7237

Source: https://www.webometrics.info/en/search/Rankings/

*Lower is better

Table 5 portraits the performance of NLUs in webometrics ranking of universities worldwide. Though the rankings for indicators like impact, openness, and excellence are based on international comparisons, the university's overall position is ranked nationally at country ranking.In the national rankings of the Webometrics ranking system, NLSIU emerged at a strong position, securing 344th place followed by WBNUJS (353) and NALSAR (438). DNLU and MNLUA ranked lower among the NLUs nationally, placing at 2056 and 2013 respectively. Interestingly, 82% of NLUs fall within the same rank (8183) for openness, whereas NLSIU leads the way among these NLUs with a position of 6258th, followed by WBNUJS at 6929thand NALSAR at 7174th respectively. Based on excellence indicator, NLUs seem to fall within a narrow range of ranks from 6291 to 7237. Most, at around 91%, share the same rank (7237thglobally). However, WBNUJS stands out with a slightly better ranking than NLIU in terms of research publication quality, as evidenced by their respective rankings (6291stand 7237th).The visibility of NLUs is evaluated by the indicator"impact" provided by

the webometrics ranking. This indicator considers the number of external links from high-impact websites pointing to NLUs webpages. Interestingly, 68% of NLUs fall within the range of 10,000 to 18,500 rankings. Notably, NALSAR University stands out with a higher visibility ranking compared to the more prestigious NLUs, NLSIU (ranked 5532nd) and WBNUJS (ranked 7800th).

Correlation between Ranking Systems: Spearman's rank correlation was computed to assess the relationship between rankings of PSI, NIRF and Webometrics. Results of the spearman correlation in the Table 6,exhibited that there was a strong positive association between NIRF & Webometrics rankings which was statistically significance at r (9) = .845, p = .001 > α. But a negative correlation was observed among the rankings of PSI & NIRF (r (9) = - .199, p = < .557) and PSI & Webometrics (r (9) = --.142, p = < .676).

The estimated p value < .001 infers that 95% of probability for a strong rejection of Ho = **There is no significant association between the ranking of NIRF, Webometrics"** and they show a true relationship between NIRF and Webometrics rankings. However, the p value =>0.05 for PSI & NIRF (0.557) and PSI & Webometrics (0.676) failed to reject the Ho = "**There is no significant association between the ranking of PSI and NIRF, Webometrics".** It divulges that the relationship between PSI, and NIRF, Webometrics ranking are statistically significant different and the parameters are also different from the specified value.

Table 6 Spearman Correlation Results between ranking of NIRF, Webometrics and PSI

Rankings	rho	t statistics	p value	Relationship
PSI & NIRF	-0.199	2.262> 0.610	0.557	Negative
PSI & Webometrics	-0.142	2.262> 0.431	0.676	Negative
NIRF & Webometrics	0.845	2.262< 4.749	0.001	Positive

Websites Quality on Ranking System: Website quality encompasses a multitude of factors, including user experience, design aesthetics, informative content, and establishment of trust, credibility. A commitment to excellence in all these areas fosters a compelling online presence. However, this study reveals that there is a negative correlation between website quality and NIRF, webometrics rankings. Webometrics utilizes Ahrefs Majestic which is a SEO backlink analysis tool concentrate on backlinks, keyword optimization, Meta descriptions and internal linking to evaluate the visibility of higher educational institutions. On the contrary,

Google PSI is a website performance analysis tools that mainly focuses on page load speed, performance, and proper use of code to provide a better user experience thus, improve the SEO indirectly and smoothen user experience through fast loading time. This divergence in varying perspectives and research methodologies employed resulted in negative correlation between website quality and webometrics ranking.

Webometrics and NIRF are primarily intended to rank the performance of the universities as an education system as a whole however, webometrics utilizes web impact metrics as one of the major criteria (50%) to evaluate the performance of the universities in web environment.

A common indicator, research productivity and its impacts of the universities were found among NIRF and Webometrics under the criteria of professional practice with openness, excellence respectively. This commonality might be the reason for a strong positive correlation (rho = 0.845) between NIRF and Webometrics.

CONCLUSION

Unlike previous studies [21] that focused on website size and online presence, this research provides a user-cantered approach. It evaluates the websites of NLUs based on real-world user experience. This includes website performance, accessibility for people with disabilities, adherence to recommended design practices and SEO. Furthermore, this research delves deeper than evaluating website quality alone. It also ranks the NLUs using three different ranking systems: NIRF (National), webometrics (International) and Google PSI (website quality). By comparing and correlating these rankings, the study aims to uncover a potential connection between a well- designed website and overall ranking of NLUs.

It revealed that NLUs websites need significant improvement in various aspects of user experience measured by the metrics of Google PSI. 50% of the NLUs followed best practices to a good extent. However, SEO remains a major weakness, with 87.5% of NLUs needing improvement. The study found no NLU website that consistently excelled in all audits of performance, accessibility, best practices, and SEO. It shows that the prestigious national law universities in India are ineffective in the information era because of lack of rationale for their web policy. By focusing on these areas, they can considerably enhance real-world user experience, increase accessibility of information for all stakeholders and strengthen their digital presence and communication in the digital era.

The participation of 11 out of 26 NLUs in the NIRF ranking suggests a potential lack of interest or concerns about the ranking methodology and procedures among some NLUs. The Bar Council of India (BCI), as a regulatory body for legal education, could explore

ways to incentivize NLUs to participate in the NIRF rankings, promoting transparency and comparability in legal education.

The scope of the study may have broadened to include all legal educational institutions with a wider range of webometric indicators, to get a deeper understanding of the website quality and its impact on different university ranking systems.

To stay abreast of the NLUs' continuously evolving online presence, which reflects their growing academic achievements, regular evaluations are crucial. These evaluations help to assess the quality of their websites and their impact on various university ranking systems.

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Network Security Management: Protecting Digital Infrastructure Using Artificial Intelligence among Centralised Libraries

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Abstract

Network security management is a vital discipline for protecting digital infrastructure in Centralised Libraries against increasing cyber threats. As organizations rely more on digital platforms for communication, business operations, and data storage, the risk of cyberattacks has increased dramatically. Effective network security management entails putting in place strategies and technologies that safeguard networks, devices, and data from illegal access, exploitation, and destruction. A multi-layered defence approach, often known as defence-in-depth, integrates several security measures to ensure that if one layer fails, the others continue to safeguard the infrastructure. As threats change, network security management must adapt innovative technology like artificial intelligence and automation to improve threat detection and response capabilities. This paper discusses the importance of network security management, highlights key strategies for securing digital infrastructure, and examines four pillars of security such as prevention, detection, response and recovery in the field to ensure continuous protection in an increasingly connected world.

Keywords: Network Security, Digital Infrastructure, cyberattacks, Security Management, Prevention.

INTRODUCTION

The process of managing network security is continuous calls for regular focus and adjustment. By utilizing cutting-edge tools and technologies, businesses may drastically lower their risk of

becoming targets of cyberattacks. Setting network security management as a top priority will safeguard your digital assets and guarantee your company's long-term viability and resilience in a world growing more interconnected by the day. You can maintain the security of your network and create a robust defence against online attacks with the appropriate strategy and resources.

LITERATURE REVIEW

The ransomware incident in 2002 led to the highest possible24 percent of organisations that paid the ransomware attackers' demanded amount failed to retrieve their stolen data, according to the "2022 Ransomware Trends Report" that backup and data recovery company Veeam issued this week at its Veeam ON conference[1].

Nineteen percent of ransomware victims were able to restore their data on their own without having to reimburse the attackers, according to the research, which was created by polling 1,000 international IT executives[2].

Ransomware affected 576 US organisations in 2021.

According to research, during the previous six years, the cost of phishing attempts has almost quadrupled: Today, the average yearly loss for large U.S. corporations is $14.8 million, or $1,500 per person. Insights from the experiences of 604 organizations and 3,556 cybersecurity and business leaders affected by a hack are presented in new research from IBM and Ponemon Institute. According to a Deep Instinct study, ransomware and malware grew by 435% and 358%, respectively, in 2020, despite the fact that hundreds of millions of attempted hacks took place daily. The only industry to experience a rise in ransomware attacks in 2021 was companies, which had a 3% increase from 336 assaults in 2020 to 346 attacks in 2021. Attacks related to healthcare also stayed at levels comparable to 2020 (112 attacks were recorded in 2020, compared to 109 in 2021). According to the most recent survey, the average cost of ransomware was assessed to be $996,000. The annual cost of phishing for BEC was projected to be $5.97 million. At least 34.1 million records were impacted, and the downtime alone cost $159.4 billion [3].

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spite the fact that hundreds of millions of attempted hacks took place The only industry to experience a rise in ransomware attacks in 2021 was companies, which had a 3% increase from 336 assaults in 2020 to 346 attacks in 2021[5]. Attacks related to healthcare also stayed at levels comparable to 2020 (112 attacks were recorded in 2020, compared to 109 in 2021). According to the most recent survey, the average cost of ransomware was assessed to be $996,000. The annual cost of phishing for BEC was projected to be $5.97 million[6]. PowerShell- a legitimate Windows automation tool used by developers- is now exploited by over 90% of malware families, including AgentTesla, GuLoader, AsyncRAT, DBatLoader and LokiBot.

Malware-based threats surged in the first half of 2024, up by 30% compared to the same period in 2023[7].

OBJECTIVES

This research aims to defend digital infrastructure and network security in Centralised Library management by implementing various preventive methods and strategies.

METHODOLOGY

This research is doctrinal research. The data collected is secondary data. Data are collected from sources such as e-library, books, magazines, articles, websites, AIR, etc,. The period of this research is one month.

RESEARCH GAP

Network security vulnerabilities are flaws in software or hardware that give hackers a chance to compromise a system. Weaknesses could include insufficient operating system and antivirus upgrades, as well as inadequate server surveillance and physical security.

Threats to network security are certain attack techniques that take advantage of those weaknesses. TheSome of Major network security threats

Malware: This is a software which infects the computer. The issue is serious because it is estimated that malware infects about 30% of computers in the United States[8]. Malware is a catch-all word for a number of distinct cyberthreat subtypes, and it can have a range of impacts. Certain versions slow down the system. Some virus makes it easier to exfiltrate data, while others freeze systems.

Viruses: Viruses and malware are similar in that they are designed to infect the system as far as possible. The most prevalent type of online danger is a virus, which can propagate in a variety of ways[9]. Potential vectors include compromised emails, messaging apps, websites, and even corrupted USB drives.

Worms: Worms and computer viruses are comparable, but worms can proliferate without a host file. Worms can frequently enter devices undetected and are challenging to eradicate once they have taken over a network.

Botnets: Groups of devices infected with malicious agents are known as botnets. Because these gadgets are connected, attackers can take control of them from a distance. There might not be any discernible changes on impacted devices. However, thousands of bots can devastate internal networks and the internet at large when utilized in concert.

Phishing and social engineering: Phishing is the practice of sending phony emails that trick recipients into clicking on file attachments or embedded links. These URLs take recipients to dangerous content when they click on them. Anything from malware downloads to phony eCommerce portals could be included in this content.

SQL injection attacks: Criminals target improperly configured search boxes on otherwise trustworthy websites in SQL injection attacks. Attackers can obtain information entered into certain search forms by inserting malicious code[10], which gives them useful information for social engineering attacks.

Man-in-the-Middle attacks: When hackers take over connections between network devices or between a network and external devices[11], it's known as a Man-in-the-Middle (MITM) attack. Attackers can eavesdrop on traffic in this way, obtaining information and data transfers that they can exploit for social engineering schemes or sell to other parties[12].

RESULT AND DISCUSSION

Identification of Network Security threats

Identification is the first step towards the network security management, when threats can't be avoided at least its identification makes us to avoid major issues and loses.

Here are some of the ways to identify the threats.

- **Security Protection with SDP:**These days, a lot of network perimeters extend far into the cloud. Additionally, the danger surface is continuously altered by remote working, which reduces the effectiveness of standard perimeter network protection. SDP and other cloud-adapted network security measures surround each user with an encrypted bubble that tracks them while they use remote devices, on-premises servers, and third-party software. Network segmentation restricts lateral movement throughout the network, and users can only access resources in accordance with stringent permissionsettings. In addition to offering protection, SDP facilitates the identification of risks to cloud infrastructure. Users can be closely monitored by security staff, and any efforts to violate security policies will be detected right away.
- **Aiming physical network security.** Policies are necessary for businesses to identify and eliminate physical threats to data and network infrastructure. In addition to access management methods like biometric or card scanning, security measures could include surveillance cameras and sensors to safeguard servers.
- **Antivirus tools usage.** All network devices should have malware and virus detection software installed by security professionals. Users should be able to install an authorized set of tools as part of security policies. Effective use of these tools should be covered in staff training, and they should be able to identify threats.
- **Train staff to be vigilant.** Another crucial aspect of threat detection is the human element. Employees need to understand the risks associated with social engineering and phishing. In addition to avoiding risky remote working behaviors like utilizing unprotected public wifi or insufficiently secured mobile devices, they should be aware of how to use email safely.
- **Detecting DDoS attacks.** Detecting DDoS assaults with packet monitoring software solutions is comparatively easy. Security teams should be alerted to such attacks by sudden surges in any packet variation.
- **Behaviour analytics.** Human behaviour is analysed to determine patterns and deviations from it that might seem suspicious.

Recovery from Network Security threats

Recovery includes safer withdrawal of data or sensitive information from the system. But there includes various steps and methods to safer recovery of data from threated network system. Some of them includes

- **Contain the threat:** To prevent the threat from getting worse, you must first contain it before taking any more action. To stop additional damage, begin by isolating compromised systems by removing them from the network or, in extreme situations, turning them off. Enforce multi-factor authentication on all vital systems, reset passwords, and prevent any unwanted access. Make sure to promptly patch any vulnerabilities that your security team discovers were exploited during the attack. However, unless a comprehensive security audit is completed, this might not be feasible.
- **Access the damage:** The likelihood of your business escaping a cyberattack undamaged is quite low. Therefore, assessing the amount of the damage and calculating the damages to your business should be among your first actions following an occurrence. This entails determining whether private information, including financial records, intellectual property, and consumer information, has been hacked. Examine data for corruption or encryption, noting any interruptions to vital functions like supply chain management, email servers, or customer-facing portals. The cost of ransom payments, theft, or lost revenue from business interruptions are some examples of the financial impact that you should also take into account.
- **Use safe backups to resume operations:** One of the biggest risks of a cyberattack is data loss, which can seriously harm your business. In essence, a secure backup is a copy of your data that serves as a safety net against data breaches and is kept in a different location, either physically or online. This can help you rapidly and efficiently respond to data breaches and resume operations. However, you won't be able to restore your data until your network has been thoroughly cleaned and restored.
- **Recover or rebuild the lost data:** You will only need to reconstruct the data you stored following the most recent clean backup if you haven't set up a cyber recovery system but maintain backups as part of your disaster recovery plan. Rebuilding that data would require professional assistance if it was irreparably corrupted.
- **Investigate the cause of the attack:** It's time to conduct an investigation to find out how the attack happened, why your cybersecurity system malfunctioned, and what the motivation behind the attack was after your company has resumed operations and recovered your data. In addition to assisting your company in recovering from the present attack, this will provide you with the knowledge you need to stop future occurrences of the same kind.
- **Analyse and improve your cybersecurity procedures:** Auditing your security flaws and figuring out how to make improvements to stop a recurrence of the incident is one of the most crucial things you can do following a cyberattack. Instruct your

staff on cyber hygiene and preventative techniques, update all passwords, and fortify your security procedures. The strongest defence against future intrusions into your networks is training your employees.

Prevention from Network Security threats

Best practices are:

- **Use Strong Passwords:** Make sure each password is lengthy, distinct, and intricate, incorporating special characters, numbers, and letters. Attackers will find it far more difficult to guess or crack passwords as a result.
- **Multi-Factor Authentication**: Multi-factor authentication (MFA) is an additional security measure that can greatly lower the chance of unwanted access. Before being granted access, MFA requires users to authenticate themselves using several methods.
- **Update Software Frequently:** To safeguard against vulnerabilities, keep all operating systems, apps, and antivirus software current.
- **Protect Your Network**: To stop unwanted access, install firewalls, encrypt private data, and conceal your Wi-Fi network. A network that is properly secured serves as a defense against a variety of cyberattacks.
- **Educate Staff**: Provide training to employees on how to spot phishing emails, the value of creating strong passwords, and how to report questionable activity. Employee knowledge can stop many attacks, and they are frequently the first line of defense.
- **Frequent Data Backups**: Make sure that all important data is routinely backed up. This procedure is essential for cyber disaster recovery since it enables companies to promptly restore lost data and continue operating with the least amount of interruption.
- **Use Secure Internet Communications**: Only use websites with "HTTPS" for any transactions or data exchanges. This ensures that data transmitted is encrypted and secure.
- **Reporting Suspicious Activity**: Install mechanisms to keep an eye on network activity and promptly report any questionable conduct. Minor problems can be stopped before they become serious security incidents by early detection.
- **Employee Training**: A lot of cyberattacks, including trojans and phishing, rely on tricking the intended victim into opening an attachment, clicking a link, or executing the malware. By teaching users to recognize the most recent dangers, cybersecurity awareness training helps lower the likelihood that they will fall for them.

- **Firewall:** The foundation of any network security design is a firewall. Potential inbound threats and outgoing data exfiltration will be detected by an NGFW, which will then prevent these malicious data flows from flowing beyond the network boundary.
- **Patching**: A lot of threats, including some worms, may move to new systems by taking advantage of unpatched vulnerabilities. Patches and upgrades should be applied promptly to help seal these security holes before an attacker may take advantage of them.
- **Micro segmentation**: By establishing a trust barrier around every application, micro segmentation makes it possible to detect and stop illegal or malicious requests. Software-defined perimeter (SDP) tools can be used for micro segmentation.
- **Access Management**: Malware and cybercriminals frequently gain access to and misuse authentic user accounts by using stolen login credentials. By giving users and apps only the permissions required for their tasks, least privilege access management reduces the potential harm that a hacked user account could cause.
- **Antivirus and Antimalware**: These programs are capable of detecting and eliminating malware infections. By implementing these features at the network and endpoint levels, ransomware, trojans, and other malware threats can be warded off.
- **Data Loss Prevention** : A number of malware types are made to steal and exfiltrate private data from a company's network. An business can identify and stop these outbound data streams before they endanger consumer and corporate data by implementing DLP.
- **Incident Response**: A successful hack will ultimately occur in any company. The likelihood of a prompt, accurate response that reduces harm to the company and its clients is increased when an incident response team and plan are established prior to a security occurrence.

CASE LAWS

Poona Auto Ancillaries'Pt. Ltd., Pune Versus Punjab National Bank, HO New Delhi & Others

In 2013, in one of the largest compensations awarded in legal adjudication of a cyber-crime dispute, Maharashtra's IT secretary Rajesh Aggarwal had ordered PNB to pay Rs 45 lakh to the Complainant Manmohan Singh Matharu, MD of Pune-based firm Poona Auto Ancillaries. A fraudster had transferred Rs 80.10 lakh from Matharu's account in PNB, Pune after Matharu responded to a phishing email. Complainant was asked to share the liability since he responded to the phishing mail but the Bank was found negligent due to lack of proper security checks against fraud accounts opened to defraud the Complainant.

Sreekanth C.Nair vs Licensee/Developer (2008) [Blocking of Website]

A student of ASCL, came across the website "www.incometaxpune.com", and on visiting the said site, the complainant was taken to a pornographic site and move the court for blocking order against the website. The court ordered that only when the authorities enumerated under Clauses (i) to (vii) when moved were either not inclined or had refused to prefer a complaint to the Director, CERT-In, then the court could be moved for a direction to the officer concerned.

Shankar vs State Rep. [2010]

The petitioner had secured access unauthorisedly to the protected system of the Legal Advisor.

CONCLUSION

Individuals and organizations must navigate a complex and ever-changing cyber threat landscape. In recent years, many new cyber risks have developed, and hackers have honed their tools and strategies. As a result, organizations confront a variety of sophisticated cyber-attacks. Many of these attacks occur across the network, making good network security critical to a corporate cybersecurity plan. To execute such a program, however, an rganization must first understand the major network security dangers that it faces, as well as the best techniques for protecting against them.Individuals that invest in these methods and procedures can strengthen their network security and better defend themselves against the growing number of cyber-attacks.

AWARENESS AND SUGGESTIONS

In recent times, the Tamil Nadu State Government has also taken the initiative and raised awareness through caller tones, urging people not to answer any strange video calls or even video calls from officials. Because this is a new trend in cybercrime, it may involve scanning your face, creating morphogen images, and demanding a ransom.

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AI-Powered Law Libraries: Transforming Legal Knowledge Management

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Abstract

The rise of Artificial Intelligence (AI) is revolutionizing legal knowledge management, transforming traditional law libraries into "Smart Law Libraries." These AI-powered systems are making legal research faster, more precise, and highly efficient. With advanced technologies like Natural Language Processing (NLP), machine learning, and predictive analytics, legal professionals can now access case laws, statutes, and precedents with unprecedented accuracy. AI-driven tools streamline document organization by automating classification, tagging, and summarization, allowing law firms, courts, and academic institutions to manage vast amounts of legal data effortlessly. Additionally, AI enhances legal research by identifying relevant legal principles, improving search results, and even suggesting case strategies based on past judgments. As the legal field embraces AI, Smart Law Libraries are not only improving efficiency but also reshaping the way knowledge is accessed and utilized. This research explores the evolution of AI-driven legal knowledge management, its impact on legal professionals, and the future role of AI in legal research and documentation.

Keywords: Smart Law Libraries, Artificial Intelligence, Legal Knowledge Management, Legal Research, Machine Learning

INTRODUCTION

For decades, law libraries have been the foundation of legal research, providing lawyers, judges, and scholars with access to case laws, statutes, and legal commentaries. Traditionally, legal professionals had to spend hours, sometimes days, sifting through volumes of legal texts to find relevant precedents and authorities. This manual approach, while thorough, was time-consuming and often inefficient. However, with the emergence of Artificial Intelligence (AI), legal research and knowledge management have entered a new era. AI-powered tools are transforming traditional law libraries into "Smart Law Libraries," streamlining research and document management like never before.

AI-driven technologies such as Natural Language Processing (NLP), machine learning, and predictive analytics are now making it possible to retrieve legal information with remarkable speed and accuracy. Leading platforms like Westlaw Edge, Lexis+ AI, and Casetext leverage AI to process complex legal queries, identify the most relevant case laws, and even predict potential legal outcomes based on past judgments[1]. What once took hours of manual reading can now be accomplished in minutes, significantly enhancing efficiency in legal practice.

Beyond improving research speed, AI is also reshaping how legal documents are managed. Law firms, courts, and academic institutions increasingly rely on AI to classify, tag, and summarize vast collections of legal data[2]. Intelligent legal assistants can extract key insights from judgments, contracts, and legal provisions, reducing manual workload and minimizing errors. This shift allows legal professionals to focus more on critical thinking and strategic decision-making rather than spending excessive time on administrative tasks.

AI-Powered Information Retrieval in Smart Law Libraries

The ability to retrieve legal information quickly and accurately is fundamental to the practice of law. Traditionally, legal research involved exhaustive manual searches through case law, statutes, legal commentaries, and digests—often requiring significant time and effort. The introduction of Artificial Intelligence (AI) in legal research has transformed this process, making it faster, more intuitive, and highly precise. AI-powered information retrieval systems in smart law libraries are not only enhancing efficiency but also reshaping how legal professionals interact with legal texts. By utilizing advanced natural language processing (NLP), machine learning,

1 Surden, H. (2019). *Artificial Intelligence and Law: An Overview*. Harvard Journal of Law & Technology, 33(2), 1-35.

2 Ashley, K. D. (2017). *Artificial Intelligence and Legal Analytics: New Tools for Law Practice in the Digital Age*. Cambridge University Press.

and semantic search, AI has revolutionized legal knowledge management, bridging the gap between raw data and actionable insights.

A striking advantage of AI-driven legal research tools is their ability to understand complex queries in a way that mirrors human reasoning. Traditional legal databases relied on Boolean searches, requiring exact keyword combinations and operators to refine results. This often led to information overload or, conversely, missing relevant cases due to imprecise phrasing. AI-powered systems, equipped with NLP, interpret legal queries in a more conversational and conceptual manner. For example, instead of requiring a rigid search term like "doctrine of promissory estoppel in contract law," an AI system can process a more fluid query such as "How does the doctrine of promissory estoppel apply in contractual disputes?" and still retrieve highly relevant cases and legal analyses[3]. This shift significantly lowers the entry barrier for junior lawyers, researchers, and even laypersons who may not be familiar with precise legal terminology.

However, while NLP enhances accessibility, the real game-changer is machine learning. Unlike conventional search engines that simply retrieve documents based on textual similarity, machine learning-powered systems continuously improve by analyzing legal precedents, citation networks, and judicial reasoning patterns. Over time, these systems become more adept at recognizing which cases hold the most legal weight and which statutes have the strongest jurisprudential authority. For instance, AI can identify emerging legal trends by analyzing how courts are applying particular doctrines across jurisdictions, which is invaluable for legal practitioners navigating uncertain or evolving areas of law[4]. This not only saves time but also empowers lawyers to make data-driven legal arguments, reinforcing their positions with the most relevant and persuasive precedents.

Another major development is semantic search, which moves beyond traditional keyword matching to understand the deeper meaning behind legal concepts. A common challenge in legal research is that different jurisdictions may use varying terminology for similar principles. For example, in contract law, the idea of "anticipatory breach" in common law may be framed differently in civil law systems. AI-driven research tools overcome this challenge by mapping legal concepts across jurisdictions, ensuring that researchers retrieve the most relevant information even when phrasing differs[5]. This has significant implications for comparative law research, as

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4 Ashley, K. D. (2017). *Artificial Intelligence and Legal Analytics: New Tools for Law Practice in the Digital Age*. Cambridge University Press.

5 Katz, D. M., Bommarito, M. J., & Blackman, J. (2020). *A General Approach for Predicting the Behavior of the Supreme Court of the United States*. PLoS ONE, 15(4), e0231765.

it allows lawyers and academics to explore how different legal systems interpret similar legal issues—an invaluable resource for cross-border litigation, international arbitration, and global policy development.

Beyond improving legal search capabilities, AI is also transforming case law analysis and citation tracking. Traditional legal citators like Shepard's (LexisNexis) and KeyCite (Westlaw) have long been used to check whether a case remains good law. AI enhances this function by not only verifying citations but also predicting the future relevance of cases. By analyzing judicial trends and citation patterns, AI can indicate whether a particular ruling is gaining or losing influence within legal discourse[6]. This predictive capability is especially important for appellate litigation and policy-driven cases, where understanding the evolving judicial landscape can shape legal strategy.

Despite its transformative potential, AI-powered legal research is not without its challenges. One concern is algorithmic bias, as AI systems are only as good as the data they are trained on. If historical case law reflects systemic biases—whether in sentencing disparities, contract enforcement, or judicial interpretations—AI systems may inadvertently reinforce these biases rather than mitigate them. Additionally, while AI can retrieve information with remarkable efficiency, it lacks the ability to engage in nuanced legal reasoning. Legal arguments are often built on interpretation, policy considerations, and judicial discretion, which AI, at least in its current state, cannot replicate. This underscores the need for AI to be a tool that supplements human expertise rather than replaces it.

Looking ahead, the integration of AI in smart law libraries is likely to evolve in profound ways. One promising development is the use of AI for legal argument synthesis, where systems not only retrieve relevant cases but also suggest possible legal arguments based on past rulings and statutory interpretations. AI may also play a key role in automating contract analysis, predicting litigation outcomes, and even generating real-time legal insights during court proceedings. While these advancements will make legal research more efficient, they also raise important ethical and regulatory considerations regarding AI's role in shaping legal decision-making.

In sum, AI-powered information retrieval has fundamentally reshaped the landscape of legal research. By making legal knowledge more accessible, intuitive, and analytically rich, AI is not just improving efficiency—it is democratizing access to legal information, ensuring that law libraries remain dynamic hubs of innovation. However, as AI continues to evolve, it is crucial to strike a balance between technological advancement and human legal expertise.

6 Branting, L. K. (2021). *Automated Legal Text Analysis for Intelligent Legal Information Systems*. Artificial Intelligence and Law, 29(3), 285-310.

While AI can provide the tools, it is ultimately human judgment that gives law its meaning and moral compass.

Automation of Legal Documentation Management in Smart Law Libraries

Legal documentation plays a crucial role in the legal ecosystem, forming the foundation for legal research, case management, regulatory compliance, and contract administration. Traditionally, managing legal documents required manual sorting, indexing, and retrieval, which was time-consuming and prone to human error. The introduction of artificial intelligence (AI) has dramatically improved this process, enabling smart law libraries to automate document management with enhanced efficiency, accuracy, and accessibility[7]. By leveraging machine learning, natural language processing (NLP), and intelligent document recognition, AI is reshaping how legal professionals interact with legal texts, reducing administrative burdens and allowing for deeper analytical engagement with the law[8].

AI-Driven Document Classification and Organization

One of the fundamental challenges in legal documentation has always been efficient classification and retrieval. Traditional legal libraries and databases relied on structured indexing systems, where librarians or legal researchers had to manually categorize and tag documents under relevant legal principles and jurisdictions. However, AI-driven systems now automate this process by analyzing the textual content of legal documents, identifying key legal concepts, and categorizing them accordingly[9].

Another important development is AI-powered citation tracking. Traditional legal citators like Shepard's or KeyCite have long helped legal professionals verify whether a case remains valid. AI enhances this function by not just identifying citations but also analyzing citation networks to determine how frequently and in what context a case has been referenced[10]. This allows lawyers and researchers to assess the real-world influence of a legal precedent over time, helping them prioritize more authoritative sources in their legal arguments.

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Automated Document Summarization and Legal Insights

With the sheer volume of legal texts, manually reviewing every document is impractical. AI has introduced automated legal summarization tools that extract key arguments, judicial reasoning, and legal principles from case law, contracts, and legislation[11]. Unlike traditional summarization, which simply condenses text, AI-driven tools analyze the logical flow of legal reasoning to produce summaries that retain the essence of legal arguments.

For legal practitioners, this means faster access to case law summaries without needing to read lengthy judgments in full. For example, a lawyer preparing for a hearing on constitutional rights may not have time to read multiple hundred-page Supreme Court judgments. AI can provide concise summaries that highlight the court's reasoning, dissenting opinions, and the broader legal impact of the ruling[12]. Similarly, legislators and policymakers can use these tools to quickly review judicial interpretations of statutes to assess their real-world application.

Contract Automation and Smart Legal Templates

Contract management is a complex and often tedious aspect of legal practice, requiring careful drafting, review, and negotiation. Traditionally, lawyers spent hours drafting contracts from scratch, ensuring compliance with legal standards while tailoring agreements to specific needs. AI-powered contract automation tools have streamlined this process by providing intelligent contract templates that auto-fill standard clauses and identify potential legal risks[13].

For instance, AI-powered platforms like Kira Systems and LawGeex analyse contracts to detect problematic clauses, non-compliant terms, or inconsistencies with prior agreements. This is particularly useful in corporate law, where businesses often deal with large volumes of contracts. Instead of manually reviewing every contract for compliance with regulatory changes, AI systems can scan documents and flag issues, allowing lawyers to focus on high-level negotiation and strategic decision-making[14].

Another major development is the rise of smart contracts, which are self-executing agreements built on blockchain technology. These contracts automatically enforce terms

11 Branting, L. K. (2021). *Automated Legal Text Analysis for Intelligent Legal Information Systems*. Artificial Intelligence and Law, 29(3), 285-310.

12 Surden, H. (2019). *Artificial Intelligence and Law: An Overview*. Harvard Journal of Law & Technology, 33(2), 1-35.

13 LawGeex. (2022). *The Future of AI in Contract Review*. Legal Technology Review, 18(1), 55-78.

14 ROSS Intelligence. (2021). *AI and Legal Compliance: Emerging Trends*. Legal Practice Journal, 22(2), 102-118.

without human intervention, reducing disputes and ensuring compliance. For example, in a supply chain agreement, payment can be released automatically once goods are delivered and verified. While still in the early stages of adoption, smart contracts have the potential to revolutionize commercial transactions by eliminating inefficiencies and reducing legal ambiguities[15].

Legal Document Review and Compliance Automation

Legal compliance is another area where AI is making a significant impact. Organizations are required to comply with an ever-evolving set of regulations, ranging from data protection laws to corporate governance requirements. AI-driven compliance tracking tools now help businesses and legal teams stay up to date with regulatory changes, ensuring that contracts, policies, and corporate filings remain compliant with the latest legal standards[16].

AI-based document review has also transformed the litigation process, particularly in the realm of e-discovery. In large-scale litigation, parties are often required to review thousands of documents to locate relevant evidence. Traditionally, this was an expensive and labor-intensive process. AI has streamlined e-discovery by using predictive coding, where the system learns from human reviewers to identify the most relevant documents[17]. It can also detect privileged or confidential communications, ensuring that sensitive legal documents are not inadvertently disclosed.

For example, in a corporate fraud investigation, AI-driven document review tools can scan thousands of internal emails and financial records to detect patterns indicative of misconduct[18]. This capability allows legal teams to conduct more thorough investigations in a fraction of the time it would take using manual review methods.

Practical Considerations and Limitations

While AI-driven legal documentation management has clear benefits, it is not without challenges. One key limitation is that AI systems still require high-quality training data to

15 LawGeex. (2022). *The Future of AI in Contract Review*. Legal Technology Review, 18(1), 55-78.

16 ROSS Intelligence. (2021). *AI and Legal Compliance: Emerging Trends*. Legal Practice Journal, 22(2), 102-118.

17 Ashley, K. D. (2017). *Artificial Intelligence and Legal Analytics: New Tools for Law Practice in the Digital Age*. Cambridge University Press.

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function effectively. If an AI tool is trained on biased or incomplete datasets, it may produce unreliable results[19].

Additionally, while AI can automate routine legal tasks, it does not replace the need for human legal expertise. Legal reasoning often involves nuanced interpretation and policy considerations that AI cannot fully grasp. AI tools can identify trends in case law, but they cannot engage in the kind of strategic thinking that skilled lawyers bring to litigation, negotiation, and legal drafting[20].

Another consideration is data security. Legal documents often contain sensitive and confidential information. As AI-powered legal management systems rely on large datasets, ensuring the security and privacy of legal documents is a pressing concern. Law firms and organizations must implement strong data protection measures when integrating AI into their legal workflows[21].

Integration of AI in Law Firm Knowledge Management Systems

Knowledge management has always been a critical function in law firms, ensuring that legal professionals have access to the right information at the right time. Traditionally, knowledge was stored in large legal libraries, internal case repositories, and research memos. However, the increasing complexity of legal data and the need for real-time decision-making have created challenges in managing and retrieving knowledge effectively. Artificial intelligence (AI) is transforming this landscape by introducing advanced search mechanisms, automated document classification, predictive analytics, and personalized knowledge delivery. AI-driven systems help law firms optimize efficiency, reduce the risk of human oversight, and enhance their ability to provide well-informed legal counsel.

AI-Powered Knowledge Retrieval and Search Optimization

One of the most significant contributions of AI in legal knowledge management is the improvement of search and retrieval mechanisms. Traditional keyword-based search functions often return an overwhelming number of documents, many of which are only tangentially relevant. AI-driven search systems, leveraging natural language processing (NLP) and machine

19 Branting, L. K. (2021). *Automated Legal Text Analysis for Intelligent Legal Information Systems*. Artificial Intelligence and Law, 29(3), 285-310.

20 Katz, D. M., Bommarito, M. J., & Blackman, J. (2020). *A General Approach for Predicting the Behavior of the Supreme Court of the United States*. PLoS ONE, 15(4), e0231765.

21 ROSS Intelligence. (2021). *AI and Legal Compliance: Emerging Trends*. Legal Practice Journal, 22(2), 102-118.

learning, can understand the intent behind a search query and deliver results based on contextual relevance rather than exact keyword matches.

For instance, when a lawyer searches for precedents related to corporate fraud, AI does not just retrieve cases that contain the exact phrase but also identifies judgments discussing financial misrepresentation, regulatory violations, and white-collar crime. This contextual understanding reduces the time spent sifting through documents and ensures that legal professionals access the most pertinent materials. Furthermore, AI enhances search ranking by prioritizing results based on judicial importance, previous citation frequency, and applicability to the current legal matter. This intelligent ranking prevents vital information from being buried under less relevant content and improves the efficiency of legal research[22].

Predictive Analytics for Legal Decision-Making

AI is also reshaping how law firms use past data to guide current decisions. Predictive analytics, powered by AI, analyzes historical case outcomes, legal arguments, and regulatory shifts to offer data-driven insights into litigation risks and case probabilities. By processing thousands of previous rulings, AI can estimate the likelihood of success for a particular legal argument, helping attorneys craft more effective case strategies.

For instance, if a firm is representing a client in an employment dispute, AI can analyze past rulings by a specific judge to determine patterns in decision-making. If the judge has a history of favoring employees in wrongful termination claims, the firm can use this insight to adjust its negotiation strategy, possibly favoring early settlements. Similarly, in corporate law, AI can analyze previous contract disputes to identify clauses that frequently lead to litigation, allowing firms to draft agreements that minimize potential legal risks[23].

Beyond litigation, AI's predictive capabilities extend to regulatory compliance. Financial institutions, for example, rely on AI to anticipate changes in tax laws and data privacy regulations, ensuring that their internal policies remain aligned with evolving legal requirements. This proactive approach reduces the risk of non-compliance and potential legal penalties.

22 Surden, H. (2019). *Artificial Intelligence and Law: An Overview*. Harvard Journal of Law & Technology, 33(2), 1-35.

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Personalization of Legal Knowledge Systems

Traditional legal research tools provide uniform results to all users, regardless of their specialization. AI-driven knowledge systems, however, offer personalized recommendations based on a lawyer's specific area of practice and past research behaviour.

Additionally, AI enhances internal knowledge sharing within firms. In large organizations, expertise is often fragmented across different practice groups. AI-driven systems can bridge these gaps by identifying subject matter experts within the firm and recommending their past work to relevant colleagues. For instance, an attorney handling a complex cross-border acquisition may receive suggestions for internal memos or due diligence reports written by colleagues with prior experience in similar transactions. This kind of knowledge-sharing mechanism prevents duplication of effort and ensures that firms leverage their collective expertise effectively.

AI in Collaboration and Document Drafting

AI also facilitates collaboration among legal professionals by integrating with document management systems. Smart legal drafting tools, powered by AI, assist lawyers in drafting contracts and pleadings by suggesting commonly used clauses, flagging inconsistent language, and even predicting areas of potential dispute.

For example, if an attorney is drafting a supply chain agreement, AI can suggest standard force majeure clauses based on industry best practices and recent judicial interpretations. Additionally, AI-driven contract analytics can identify provisions that have historically led to litigation, enabling lawyers to modify contract terms proactively to reduce risks.

Furthermore, AI-based virtual legal assistants and chatbots enhance internal collaboration by allowing legal professionals to retrieve knowledge quickly. If an associate needs to find the latest guidance on environmental compliance for manufacturing firms, they can query an AI-powered assistant and receive a concise summary, rather than spending hours searching through databases manually.

Ensuring Compliance and Risk Management

The legal landscape is constantly evolving, with new regulations emerging across different industries and jurisdictions. AI plays a crucial role in keeping law firms updated on these changes. AI-powered compliance tracking tools monitor global regulatory updates in real time, ensuring that firms remain aligned with the latest legal requirements.

For example, in the wake of stricter data protection laws, AI can scan a firm's internal policies and identify areas that may need revision to comply with new privacy regulations. This proactive approach not only reduces legal risks but also strengthens a firm's credibility in regulatory matters.

Addressing Challenges in AI Integration

While AI presents numerous advantages in legal knowledge management, its implementation is not without challenges. Law firms must invest in training attorneys and staff to effectively utilize AI tools, as a lack of familiarity can lead to underutilization. Additionally, AI systems require high-quality training data to function accurately. If the underlying dataset is incomplete or biased, the AI-generated insights may not be reliable. Therefore, continuous refinement and validation of AI models are essential to maintaining accuracy and trustworthiness.

Another critical concern is data security. Since AI-driven knowledge systems process vast amounts of confidential legal information, ensuring data privacy is paramount. Law firms must implement robust cybersecurity measures to prevent unauthorized access and comply with client confidentiality obligations.

AI-Driven Personalization in Legal Research

AI-driven personalization in legal research is revolutionizing the way legal professionals access, interpret, and apply legal information. Traditionally, legal research has been an exhaustive and time-consuming process, requiring lawyers to manually navigate through vast legal databases, case law archives, and statutory materials. This conventional approach often led to inefficiencies, repetitive searches, and the risk of overlooking critical precedents. However, with the rapid evolution of artificial intelligence, particularly in machine learning, natural language processing (NLP), and predictive analytics, legal research has become more precise and tailored to individual user preferences. AI-driven systems now analyze past search behaviors, legal specializations, and contextual preferences to deliver highly relevant legal insights, thereby significantly enhancing research efficiency and accuracy.

The Mechanisms Behind AI-Powered Personalization

One of the primary ways AI achieves personalization in legal research is through continuous learning and adaptive ranking algorithms. AI-powered legal databases such as Westlaw Edge, Lexis+, and Bloomberg Law employ advanced machine learning models that analyze user

interactions to refine search results over time[24]. These platforms track search queries, frequently accessed cases, and cited legal precedents to customize future recommendations. For instance, if a corporate lawyer frequently researches contract disputes, the AI system will prioritize related case law, statutory interpretations, and regulatory updates in subsequent searches[25]. This evolving learning process ensures that legal professionals receive more relevant information with each search, reducing redundancy and increasing research efficiency.

Additionally, AI-driven legal research tools leverage NLP to bridge the gap between human language and complex legal terminology. Unlike traditional keyword-based searches, which often yield broad and sometimes irrelevant results, NLP-powered systems understand the context of a query. A lawyer searching for "liability in AI-generated contracts" will not only receive results containing the exact phrase but also related cases discussing legal accountability in automated contract execution[26]. This capability allows AI to interpret the intent behind queries, making legal research more intuitive and user-friendly.

Furthermore, AI systems enhance personalization by integrating legal knowledge graphs—complex networks that map relationships between legal concepts, case precedents, statutes, and scholarly writings. These knowledge graphs enable AI to provide contextual recommendations, ensuring that users gain a more holistic understanding of their research topic. By establishing connections between seemingly unrelated cases or legal doctrines, AI helps uncover nuanced arguments that might otherwise be overlooked.

AI-Powered Virtual Legal Assistants and Real-Time Personalization

Another major advancement in AI-driven personalization is the integration of AI-powered virtual legal assistants. These assistants, embedded within smart law libraries and legal databases, provide real-time research support by answering legal queries, retrieving case law, and summarizing key legal principles. Unlike traditional search engines, these AI assistants remember previous interactions and refine their responses based on user preferences. This feature enables lawyers to conduct research in a conversational manner, improving accessibility and usability.

24 Surden, H. (2019). *Artificial Intelligence and Law: An Overview*. Harvard Journal of Law & Technology, 33(2), 1-35.

25 Branting, L. K. (2021). *Automated Legal Text Analysis for Intelligent Legal Information Systems*. Artificial Intelligence and Law, 29(3), 285-310.

26 Katz, D. M., Bommarito, M. J., & Blackman, J. (2020). *A General Approach for Predicting the Behavior of the Supreme Court*. PLoS ONE, 15(4), e0231765.

For example, a lawyer working on an international arbitration case may ask an AI assistant to find relevant precedents across multiple jurisdictions. Instead of performing separate searches for each legal system, the AI assistant synthesizes data from various legal databases and presents a curated list of applicable cases and statutes. This cross-jurisdictional research capability is particularly beneficial for multinational firms and legal practitioners handling complex international disputes.

Challenges and Limitations of AI-Driven Personalization

Despite its transformative benefits, AI-driven personalization in legal research is not without challenges. One of the foremost concerns is data privacy. AI tools analyze user search history and preferences to deliver personalized results, raising potential confidentiality risks, especially when dealing with sensitive client information. Many legal professionals worry about how AI platforms store and use this data, necessitating robust encryption measures and strict compliance with data protection regulations.

Another challenge is the potential for AI-induced research bias. Since AI recommendations are based on a user's past searches and cited materials, there is a risk of reinforcing existing viewpoints while overlooking alternative legal interpretations. This "filter bubble" effect may limit exposure to diverse legal arguments, potentially affecting the quality of legal analysis. To mitigate this, AI research platforms are incorporating diversity-aware algorithms that ensure exposure to a wider range of legal perspectives.

Furthermore, there is an ongoing debate about the ethical implications of AI-generated legal research. While AI enhances efficiency, there is a concern that over-reliance on AI could diminish critical thinking and legal reasoning skills among professionals. Some legal scholars argue that AI should supplement, rather than replace, traditional legal research methods.

Future of Smart Law Libraries: AI and Beyond

The future of smart law libraries is set to evolve dramatically, driven by advancements in artificial intelligence (AI) and other emerging technologies. While AI has already streamlined legal research, automated document management, and enhanced accessibility, the next phase will go beyond these improvements. Future smart law libraries will not only act as digital repositories but will also become intelligent legal assistants, offering predictive insights, global legal connectivity, and interactive learning experiences. As technology continues to integrate

deeper into legal practice, smart law libraries will transform into dynamic hubs where AI collaborates with human expertise to refine legal reasoning, improve efficiency, and ensure access to reliable legal knowledge.

AI will continue to refine legal research, making it more context-aware and interactive. Current AI-powered legal research tools already provide case law, legal precedents, and statute references, but the next generation will anticipate researchers' needs, suggest related arguments, and highlight potential counterarguments in real time. Instead of manually searching through vast legal databases, legal professionals will receive AI-curated insights tailored to their specific case or query. This evolution will save valuable time and enhance the precision of legal arguments, reducing the risk of oversight in complex litigation. Additionally, AI-powered legal assistants will be capable of summarizing intricate legal documents, flagging key precedents, and even recommending strategic approaches based on previous judgments[27].

Another major transformation will come through the integration of blockchain technology to enhance the authenticity, security, and transparency of legal information. In legal research, ensuring the credibility of citations and case law references is crucial. Future smart law libraries may leverage blockchain-based legal databases, where every legal document is timestamped, verified, and stored on a decentralized ledger to prevent tampering[28]. This technology could prove particularly beneficial in jurisdictions where legal records are susceptible to manipulation or where access to official legal archives is limited. Moreover, smart contracts built on blockchain could automate legal compliance tracking, ensuring that law firms and researchers use the most up-to-date, legally valid documents in their cases[29].

Looking ahead, quantum computing is poised to take legal data processing to an entirely new level. While current AI models are powerful, they still rely on traditional computing limitations when analysing vast amounts of legal information. Quantum computing, on the other hand, will process complex legal queries at an unprecedented speed, allowing law firms and courts to predict case outcomes with greater accuracy. For instance, instead of simply retrieving similar past cases, quantum-enhanced AI could analyse thousands of judgments across multiple jurisdictions in seconds, identifying deep legal patterns that would take human

27 Surden, H. (2020). *Artificial Intelligence and Law: A Critical Analysis*. Harvard Law Review, 134(5), 1201-1235.

28 Branting, L. K. (2021). *Machine Learning and the Future of Legal Research*. Artificial Intelligence and Law, 30(2), 225-250.

29 Nakamoto, S. (2008). *Bitcoin: A Peer-to-Peer Electronic Cash System*. [Online] Available: https://bitcoin.org/bitcoin.pdf

researchers weeks or even months to uncover[30]. This capability could significantly impact corporate litigation, where the ability to foresee legal risks could help businesses mitigate potential liabilities before they escalate.

The future of smart law libraries is not limited to data retrieval. Emerging augmented reality (AR) and virtual reality (VR) technologies will offer immersive legal research experiences. Imagine a law student or lawyer being able to step into a virtual courtroom and interact with case law in a dynamic 3D environment. Instead of reading about legal principles in textbooks, users could visualize legal arguments, explore precedents in an interactive timeline, and even simulate trial proceedings using AI-powered virtual judges and opposing counsel[31]. This innovation would not only revolutionize legal education but also bridge the gap between theoretical knowledge and real-world legal practice, making learning far more engaging and practical.

Another critical aspect of future smart law libraries will be their role in global legal connectivity. The legal landscape is becoming increasingly international, with businesses, trade agreements, and legal disputes frequently crossing borders. AI-driven legal platforms will allow seamless access to legal information from multiple jurisdictions, translating laws and case law in real time. A lawyer in India, for example, could instantly retrieve and analyze a European Court of Justice ruling with AI-generated contextual insights that explain how the ruling could impact a case in an Indian court[32]. AI-powered multilingual legal translation tools will make cross-border legal research more accessible, breaking language barriers and ensuring that legal professionals worldwide can collaborate effectively.

In addition to research and case law analysis, AI-powered legal education hubs will become an integral part of smart law libraries. These platforms will offer personalized learning experiences, tailoring content to individual legal professionals based on their expertise, interests, and previous research patterns. AI-driven systems could recommend specific case studies, articles, and interactive training modules, ensuring continuous professional development. Future law students and junior associates could receive real-time feedback on their legal arguments, refine their research techniques, and even participate in AI-powered virtual debates to sharpen their

30 Preskill, J. (2018). *Quantum Computing in the NISQ Era and Beyond*. Quantum, 2, 79-85.

31 Milosevic, D. (2022). *Augmented and Virtual Reality in Legal Education*. Journal of Legal Technology, 15(3), 87-102.

32 Fenwick, M., Kaal, W., & Vermeulen, E. (2017). *Legal Education in the Digital Age: AI and Multilingual Legal Research*. Duke Law Review, 67(4), 321-345.

advocacy skills[33]. This transition will ensure that legal professionals stay updated with the latest legal developments while honing their analytical and reasoning abilities.

Despite these advancements, the future of AI in smart law libraries must also address concerns related to AI governance, transparency, and ethical use of technology. As AI becomes more integral to legal research and decision-making, ensuring that AI-generated legal analyses are unbiased and explainable will be crucial. Future smart law libraries will need to implement robust AI auditing frameworks to ensure that legal AI systems provide transparent, verifiable, and non-discriminatory results. Additionally, AI-driven misinformation detection tools could play a key role in preventing the spread of misleading or manipulated legal interpretations[34].

Ultimately, the future of smart law libraries will not just be about enhancing efficiency but transforming legal research into an intuitive, interactive, and globally connected process. These developments will redefine how legal professionals engage with information, bridging the gap between traditional legal scholarship and modern technological advancements. As AI continues to evolve, the role of smart law libraries will expand beyond research and documentation into active legal intelligence hubs, shaping the next era of legal practice. The integration of AI and beyond will not replace human legal expertise but will augment it, making legal professionals more effective, well-informed, and globally connected than ever before.

CONCLUSION

The rise of smart law libraries, powered by artificial intelligence, is reshaping the way legal professionals interact with legal knowledge. What was once a collection of books and digital databases is now evolving into an intelligent, responsive system that not only retrieves information but also provides insights, automates documentation, and personalizes legal research. AI has made legal research faster and more precise, allowing lawyers, researchers, and students to access relevant information in ways that were previously unimaginable.

However, the future of smart law libraries is about more than just efficiency. These systems are becoming essential partners in legal reasoning, helping professionals identify patterns, anticipate legal arguments, and connect legal principles across jurisdictions. Technologies like blockchain are enhancing data integrity, while AI-driven automation is reducing the time spent on routine tasks, allowing legal experts to focus on more complex and strategic issues.

33 Susskind, R. (2021). *Online Courts and the Future of Justice*. Oxford University Press.

34 Binns, R. (2018). *Fairness in Machine Learning: Lessons for AI Governance in Law Libraries*. Cambridge Law Journal, 77(2), 312-338.

The potential of quantum computing and virtual reality in legal research further hints at a future where accessing and analyzing legal knowledge becomes an immersive and predictive experience.

Despite these advancements, AI in legal knowledge management must be implemented thoughtfully. There is a need to ensure transparency, accountability, and fairness in AI-driven legal research to maintain trust in these systems. AI should not replace human expertise but should serve as a tool that enhances decision-making, helping legal professionals work smarter without compromising the ethical foundations of law. Legal scholars, practitioners, and technologists must collaborate to create frameworks that prevent biases, ensure data reliability, and promote responsible AI usage in legal research.

Looking ahead, smart law libraries will not just be about storing information—they will be about shaping the future of legal education, research, and practice. By integrating AI responsibly, these libraries can become more than just knowledge hubs; they can serve as intelligent legal assistants that empower professionals to navigate the complexities of law with greater accuracy and confidence. The challenge is to strike the right balance between technology and human judgment, ensuring that the legal profession benefits from innovation while preserving the core principles of justice and legal integrity.

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Transforming Citation-based Literature Search using Artificial Intelligence tools: A Comparative Analysis

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Abstract

Academic writing in research contributes with anobjective of collecting and presenting ideas and innovations logically but the profuse amount of data is inordinate. Artificial Intelligence has evolved as the main technological innovation in academic writing and research. Integrating AI in academic writingreduces the issue related to time efficiency, quality of writing, and makes the whole AI assimilation into academic writing more effortless. This paper aims to assess the effectiveness of AI powered tools in Citation-based literature research.

Keywords: Artificial Intelligence tool, Research, Academic Writing, Citation-based research

INTRODUCTION

Academic Writing in the Digital Era [1] demonstrates the ease in citing information of academic and research works in a structured and organized format. This serves as an advantage to the academic and research scholars for great article writing. Complex data centric arguments, result based logical analysis, and fact-based research is a common convention in academic writing. The shift from a data-centric model to ArtificialIntelligence research analytics aids in deeper understanding of the researcher's concepts along with proposed well-grounded arguments. However, these huge data volumes pose a challenge in conducting analysis and synthesis of

the data. The incorporation of AI tools [2,3] transpires these challenges in revolutionizing the academic writing process.

In the recent research arena, AI tools such as semantic scholar [4] contribute for the rapid analysis of literature from the immense volume of scholarly database with an additional support of automated alert for tracking the recent developments.Similarly, AI powered Advanced writing Assistants like Hemingway. Grammarly [5] extends services for enriching the grammar, organizing the article and enhances the writing clarity. Collaboration services are also rendered by reference management AI tools such as Endnote, Mendeley and Zotero [6] for automating the citation process. Further, the AI tools masters various domains of academic writing and publishing including, text generation, analysis of data, data interpretation, multilingual services, plagiarism detection and translation services. Subsequently, AI tools contributes for the new researchers in assisting with formal academic language and research terminologies for sustainable academic integrity.

AI facilitated tools for reviewing the literature are classified as citation based and sematic based. Citation-based literature review [7] explores books, book chapters, scholarly articles and academic databases by examining the references and citations. It determines the citation network, traces authors and their predominant work in the specific domain.

A semantic-based literature review [8] seeks the meaning and context, finds relevant source by examining the meaning and context, notions, themes or association in the literature used in research articles.

This paper concentrates on analysis ofcitation basedAI powered tools: Research rabbit, Litmaps, connected papers.

MATERIALS AND METHODS:

Citation-Based Literature Search:

The procedure for citation-based literature search are

Step1: Initiate the search with primary Key Articles:

- Beginthe search by choosingthe primary origin papers, articles or books in the research domain. Origin paper in the research domain could be highly cited works, recent research publications or fundamental studies which has a significant connection to the research topic.

Step 2: Determine the references for Key Article:

- Identify the appropriate citation sources for the origin paper which explores the seminal or precedent studies of the authors.

Step 3: Identify the citation methods: the Citation Networks:

- Existing citation networks namely, Web of Science, Google Scholar and Scopus can be used to ascertain the citation methods of the researchers. Google Scholar offers the backward and forward citation chains for the researchers to explore.

Step 4: Recognize Highly Cited Works:

- Recognize the relevant work with frequent citation with meta-analyses search.

Step 5: Administer AI AssistedCitation Management Tools:

- Engage AI aided tools for literature searching, reference management and visualizing the citation networks. These tools renders the researchers for tracking relationships between citations and automates the citations process.

Step 6: Traverse the Citation Repositories:

- Navigate into the citation repository such as Google scholar, Web of Science, Scopus, Science Citation Indexed and Pubmed.
- These repositories allow to search and filter for articles by title, author, and subject and based on citation countsor the date of publication.
- It automatically formats citations and create bibliographies in different citation styles (APA, MLA, Chicago, etc).

RESEARCH RABBIT

ResearchRabbit [9] is a citation-based publication discovery tool powered by Artificial Intelligence (AI). It came into operation In the year 2021[9]. It is a vivid tool for finding publications based on the seed articles related to recent and previous publications illustrated by the visualization graph [10]. It explores the repositories vertically beginning from the seed articles deeply.

To initiate the literature searching with the Research Rabbit, user has to create an account followed by creating a new collection with minimum of one publication.Further, articles can be appended to the collection for enhanced searching process.Additionally, the collections in ResearchRabbit can be grouped to a category. Research rabbit access the citation networks using pubMed's and Semantic Scholar Search Engine. It recommends the relevant articles

based on collection with its algorithm. Recommendations are contemplated in two modes: by papers and by people. Recommendations outputs are visualized using the maps. Further, articles can be listed in timeline view.

The reference snapshot images of the ResearchRabbit explore option is depictedin figure 1. Similarly, collections, visualization maps and timeline view options of ResearchRabbit is depicted in Figure 2, 3 and 4 respectively.

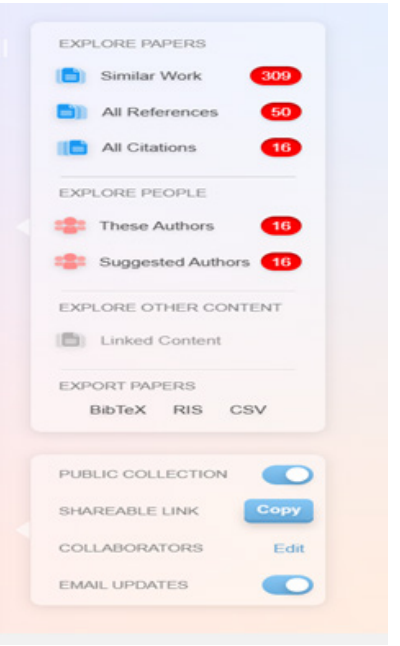

Figure 1: Exploration Options

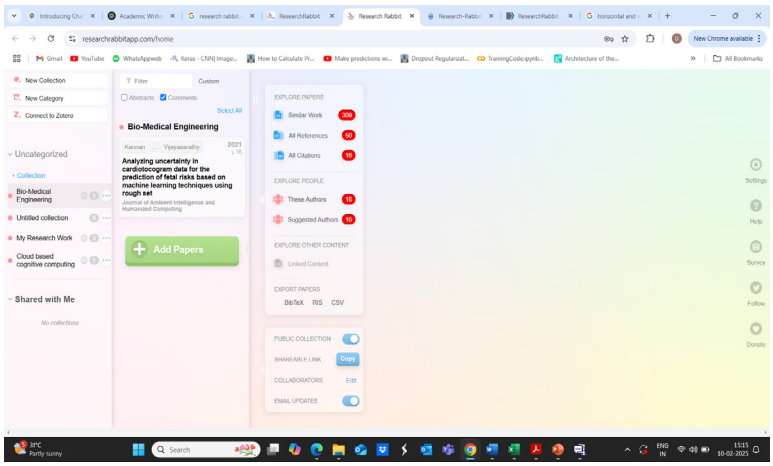

Figure 2: ResearchRabbit : Collection with a publication

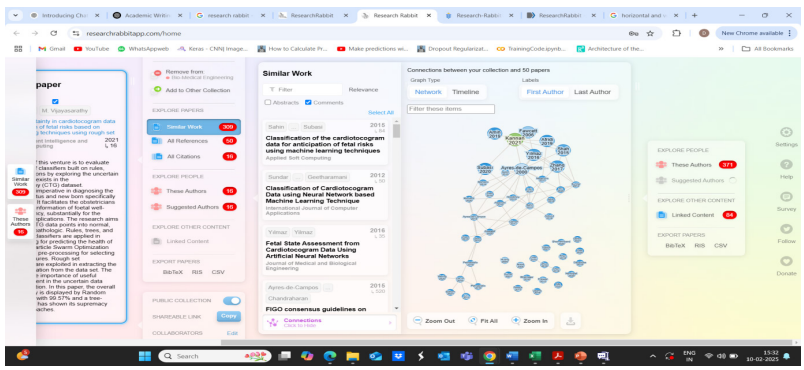

Figure 3: ResearchRabbit: Visualization Maps

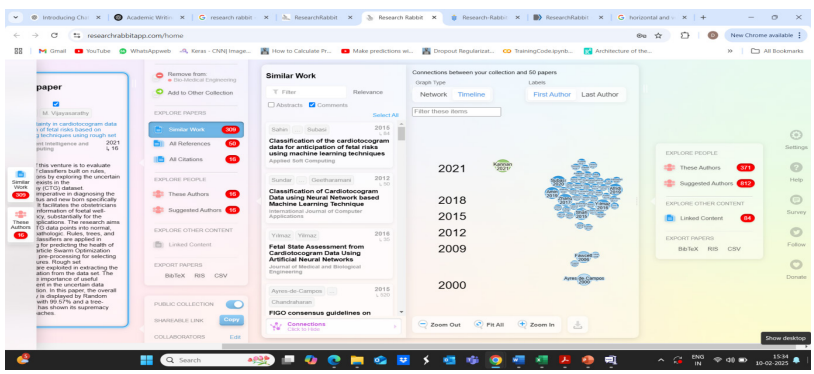

Figure 4: ResearchRabbit: TimeLine View

LITMAPS

Litmaps[11] is an AI assisted tool for which finds articles iteratively using seed papers also displays the visualization of the relevant articles with seed papers. Using this tool, reference managers are linked automatically and also articles from ORCHID profile can be imported.

Litmaps constructs search results for the input seed paper using the timeline visualization for prior and recent publications to the left and right respectively. It explores citation networks and repositories for the stronglyrelevant efficiently. Litmapsis equipped with an alert e-mail service for very recent publications relevant to the research field.

The user interface of the of the litmapsis depicted in the figure 5, further the snapshots for tag creation and reference manager importing options are illustrated in the figures 6 and 7 respectively.



Figure 5: LitMaps-Interface

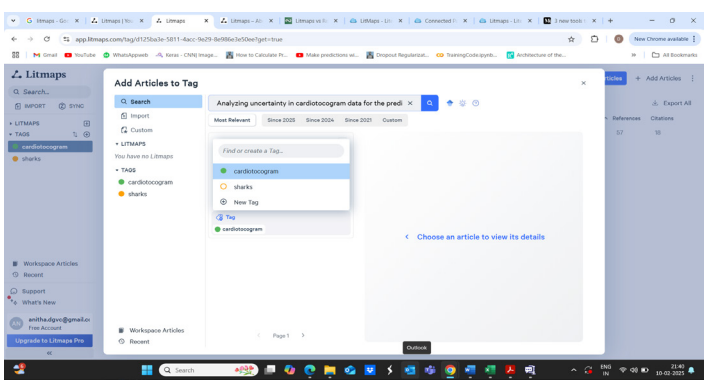

Figure 6: LitMaps: Tags Creation

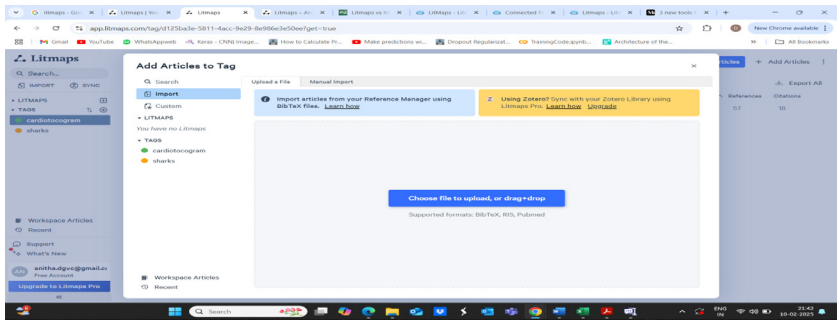

Figure 7 :LitMaps- Import to Reference Manager

CONNECTED PAPERS

Connected papers [12] is a simple and elegant AI tool used for citation-based literature searching techniques.Connected papers investigates relevant literature in regard to content similarities and presents in visual clusters. It uses specialized algorithm which searches in semantic scholar repository and identifies most relevant articles. The researcher choses the origin paper among the relevant articles. The origin paper is considered as the base paper for generating the literature graph using the similarities. The graph is created based on interconnection among papers and not based on the number of citations of the paper.

The user interface of the connected paper is shown in the figure 8, searching options like prior search, derivative search is illustrated in figures 9 and 10. The graph view of the connected papers is shown in figure 11.

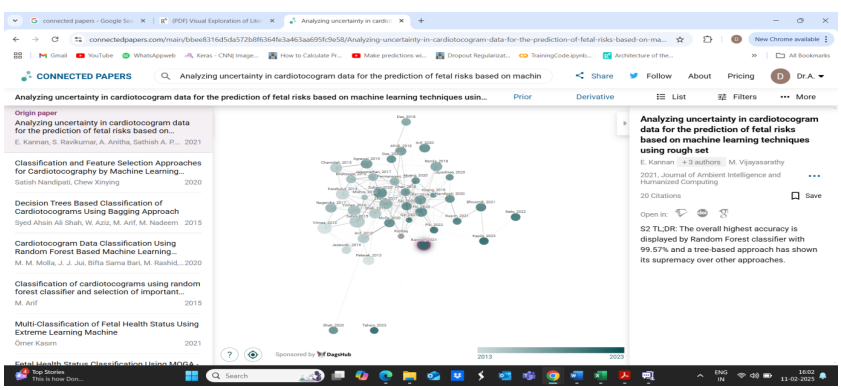

Figure 8: Connected Papers – Interface with the Origin Paper

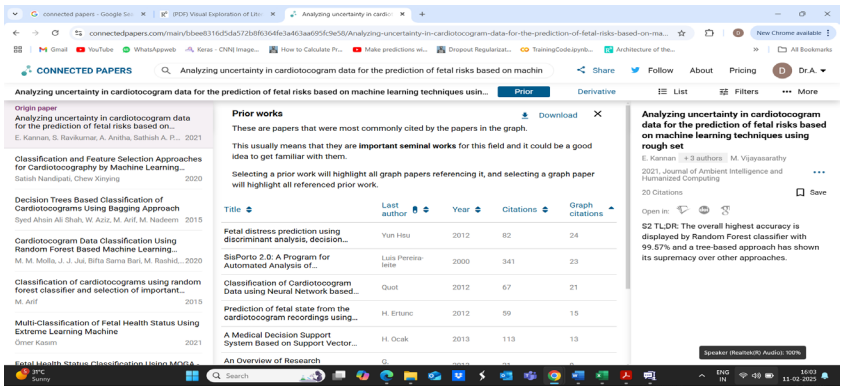

Figure 9 :Connected Papers- Prior search

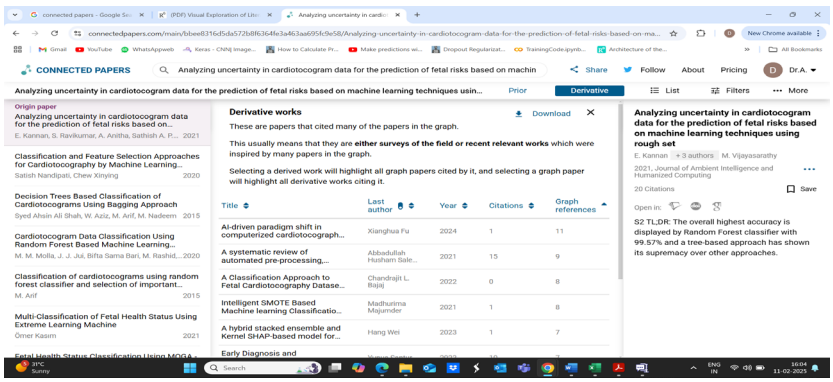

Figure 10: Connected Papers-Derivative Search

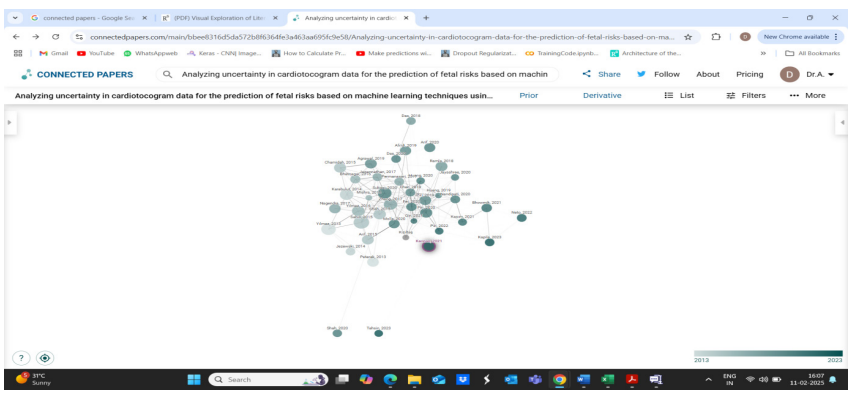

Figure 11: Connected Papers- Graph view

COMPARATIVE ANALYSIS OF RESEARCH RABBIT, LITMAPS AND CONNECTED PAPERS

The table [1] shows the comparative analysis of Research Rabbit, Litmaps and Connected Papers .

Table 1 Comparitve Analysis of Research Rabbit, Litmaps and Connected Papers

	Research Rabbit	**Litmaps**	**Connected Papers**
Best Feature	Fast Exhaustive Literature Search Prioritized List	Displays most relevant papers in batches of 10 Distinct Graph Displays Immediate Impactful Papers	Better Interface Starts searching from single paper options to filter open access journal
Unique Features	Categories and Collections	Monitor Co-Authorship Search	Switches between default view and List view
Integration to Reference Manager	Yes	Yes	No Integration
Speed	Fast	Relatively less faster	Fast
Subscription	Free	Free for Basic Features Paid version for Pro-plan	Free for 5 graphs per month

CONCLUSION

Citation-based literature search is a constructive method to follow the research development and academic improvements in the research domain. With the advent of citation network and AI powered tools, it assists the most influential sources with more relevant and recent advancements in the research field. This article had revealed the importance, features and comparative analysis of three AI Powered tools, Research Rabbit, Litmaps and Connected papers. It also emphasized the special and unique features of the tools necessitating its impact in citation-based literature search.

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Research on the Library Services provided by the Librarians to the Physically Challenged Students in Arts and Science Colleges of Tamil Nadu

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Abstract

The study delved into the contribution of Librarians for the Physically Challenged students of Arts and Science Colleges in Tamil Nadu. The goal of the study was to find out the policies for the Physically Challenged students and services provided to them. It was found that degree of library services provided to physically challenged students at Arts and Science College is average in relation to the library policies. The Library Building's accessibility is below average. The bulk of the technology and software in libraries are not accessible to the physically Challenged students according to librarians. Therefore the suggestion for the improvement with respect to the Policies, Services, Training etc. are presented.

Keywords : Library Services , Physically Challenged Students, Arts and Science Colleges,

INTRODUCTION

Academic libraries are service organizations that fulfil the information requirements of the people they serve and promote Information Literacy within the framework of the institution's mission. As service organizations, libraries are concerned about the quality of their services and how they affect the people who utilize their collections and services now and in the future. Physically Challenged students present opportunities rather than problems. They are

people with potential, just like every other student, and the academic library plays a part in helping them realize and grow that potential. Physically Challenged students should be able to fully utilize the library's resources, services, and collections thanks to its offerings. Supporting students with impairments at the start of their education is crucial to preventing them from falling behind.

Due to their issues and ignorance of the resources and services the library offers, students with disabilities might refrain from going there. Therefore, it is the responsibility of the librarians to identify, get in touch with, and inform students with disabilities about the resources and services offered by the library.

LITERATURE REVIEW

Onsinyo (2018) conducted a study on challenges of accessing library and information services for students with physical challenges in university libraries in Meru County, Kenya and found that the parking areas, pathways and entrances to the library building were not accessible to the students living with challenges. Physical library resource needs can only be met by providing a balanced visual environment, safe structure, sufficient sanitary facilities, and good terminal environment.

Grassi, Renee (2017) offered tips for libraries in developing a strategy for serving people with disabilities. These include the need to define one's goals to improve service to such population, train **library** staff annually for recognizing and serving patrons with disabilities, and assess the community environment where the **library** is located to give a sense of the types of **services** that are already provided to the **disabled.**

Skourlas, Christos. et al (2016) explained about how to integrate Institutional Repository (IR) and Learning Management System (LMS) to support accessibility of **disabled** students and students with learning difficulties (dyslexic students) in higher education. The author proposed a simple methodological approach to establish an integrating system for supporting accessibility.

There was no study conducted earlier in relating to the library services for disabled students in the Arts and Science Colleges in Tamil Nadu. To fill up this research gap the study has been conducted.

OBJECTIVE OF THE STUDY

The Study has been conducted with the following objectives:

- To examine the policies with respect to library services for the Physically Challenged students in Arts and Science Colleges in Tamil Nadu.
- To examine the facilities available for the Physically Challenged students.
- To identify the problems confronting the physically Challenged students in Arts and Science Colleges.
- To ascertain the extend of provision of budgetary to meet the library facilities required by the Physically Challenged students.

METHODOLOGY

The study was carried out among the librarians in the Arts and Science Colleges in Tamil Nadu. A total number of 100 questionnaires were distributed and collected from the librarians. Collected data were analysed using statistical tools.

DEMOGRAPHIC PROFILE OF THE LIBRARY STAFF

The particulars of the demography were collected from the librarians in the Arts and Science Colleges in Tamil Nadu.

Table No. 1 Respondents Vs Staff Gender

Sl.No	Gender	Frequency	Percentage
1.	Male	69	69.00
2.	Female	31	31.00
	Total	100	100

From the Table No.1 it is found that sample consists of a sizeable preponderance 69 (69%) of male respondents over female 31 (31%) respondents.

Table No. 2 Respondents Vs Job Experience

Sl.No.	Job Experience	Frequency	Percentage
1.	Upto 5 years	41	41.00
2.	6 – 10 years	38	38.00
3.	11 – 20 years	19	19.00
4.	Above 20 years	2	2.00
	Total	100	100

From the above Table No.2 it is found that 41% of the respondents have up to 5 years job experience followed by 6 – 10 years (38%), 11 – 20 years (19%) and 2% of them having above 20 years.

Table No. 3 Respondents Vs Nature Of Job

Sl.No.	Nature of Job	Frequency	Percentage
1.	Temporary	52	52.00
2.	Permanent	48	48.00
	Total	100	100

From the Table 3 it is found that the nature of job of 52% of the respondents are temporary and remaining 48% of them are permanent.

Table No. 4 Respondents Vs Location Of The Library

Sl.No.	Location of the Library	Frequency	Percentage
1.	Ground Floor	55	55.00
2.	I Floor	15	15.00

Sl.No.	Location of the Library	Frequency	Percentage
3.	II & Above Floor	3	3.00
4.	Separate Building / Block	27	27.00
	Total	100	100

From the Table 4 in terms of the Location of the Library, it is found that 55% of the libraries are located at Ground floor, 15% of them are at First floor, 3% of them at Second and Third floor. 27% of the libraries are in separate building / block.

Table No. 5 Respondents Vs Area Of The LibrarY

Sl.No.	Size of the Library (Area)	Frequency	Percentage
1.	Upto 3000 Sqft	56	56.00
2.	3001 – 6000 Sqft	33	33.00
3.	Above 6000 Sqft	11	11.00
	Total	100	100

From the Table 5 in terms of the Size of the Library, it is found that 56% of the libraries are in the area of 3000 Sqft, 33% of them are in the area of 3001 – 6000 Sqft. and 11% of them are in the area above 6000 Sqft.

Table No. 6 Respondents Vs Library Staff Members

Sl.No	Number of Staff Members Available	Frequency	Percentage
1.	Less than 5	79	79.00
2.	5 - 10	16	16.00
3.	More than 10	5	5.00
	Total	100	100

From the Table No. 6, it is found that 79% of the libraries have less than 5 staff members, 16% of them have 5 – 10 staff members and only 5% of them have more than 10 staff members.

Table No. 7 Respondents Vs Number Of Physiscally Challenged Students Visit Per Day

Sl.No.	Average Number of Students with Disabilities Visit Per Day	Frequency	Percentage
1.	Less than 20	69	69.00
2.	More than 20	31	31.00
	Total	100	100

From the above Table 7 it is found that 69% of the respondents say that it is less than 20 and remaining 31% of them say that more than 20 physically challenged students visit the library per day.

Table No. 8 Library Policy For The Physically Challenged Students

Sl.No.	Description	N	Mean	SD
1.	Library has a Vision, Mission policy for the Physically Challenged students	100	2.08	1.261
2.	Library has a written policy that describes services to the Physically Challenged students.	100	3.86	.725
3.	Library has Information Policy on how to request for Accommodations.	**100**	**3.60**	**.791**
4.	Accessibility is included in the procurement of library holdings.	100	3.54	.797

Sl.No.	Description	N	Mean	SD
5.	Physically Challenged students are included in the board of trustees and committees of the library.	100	1.75	.936
6.	Physically Challenged students are included in the library's access planning process	100	1.65	.968
	TOTAL / AVERAGE	100	16.48	4.357

- From the above table, it is found that the Library services with respect to the Library Policies for the Physically Challenged students are higher in case of the variables – "**Library has a written policy that describes services to the Physically Challenged students" (M = 3.86)**"**Library has Information Policy on how to request for Accommodations"(M = 3.60)** when compared with others.
- From the above table, it is also inferred that Library services with respect to the Library Policies for the Physically Challenged students are at the average level since all Mean values of the variables are between 1.65 and 3.86 out of 5.
- The overall mean value of the Library Services – Library Policies for Physically Challenged students is 16.48. This is above 54% (16.48/30 x 100).

Table No. 9 Library Building Access And Environment For The Physically Challenged Students

Sl.No.	Description	N	Mean	SD
1	**Parking areas, pathways, and entrances to the building are wheelchair-accessible**	**100**	**2.66**	**1.423**
2.	**Aisles are kept wide and clear for wheelchair users**	**100**	**2.68**	**1.302**
[3.	Wheelchair-accessible to restrooms with a well-marked signs are available in and near the library	100	2.23	.897
4.	People seated in wheelchairs can easily reach all Lifts controls	100	1.90	.302

Sl.No.	Description	N	Mean	SD
5.	Ramps and /or elevators are provided as alternatives to stairs	100	2.06	.814
6.	Lifts have both auditory and visual signals for floors	100	1.88	.327
7.	Lifts controls are marked in large print and Braille or raised notation	100	1.90	.302
8.	at least 32 inches wide doorway openings and doorway thresholds are no higher than one and half inch	100	2.41	1.164
9.	Protruding objects have been removed or minimized for the safety of users who are visually impaired	100	2.62	1.319
10.	All levels of the library are connected via an accessible route of travel or there are procedures to assist students with mobility impairments in retrieving materials from inaccessible locations	100	1.99	.772
11.	**Service desks and facilities such as book returns are wheel chair accessible**	**100**	**2.65**	**1.374**
12.	There are directional signs in high-contrast, large print and in Braille format throughout the library	100	1.93	.517
13.	Book Shelf and stack identifiers are provided in large print and Braille formats	100	1.84	.395
14.	Call numbers on book spines are printed in large type	100	1.95	.730
15.	Equipment marked with large print and Braille labels	100	1.92	.442

Sl.No.	Description	N	Mean	SD
16.	Library study rooms are available for students with disabilities	100	2.03	.858
17.	Hearing protectors, private study rooms, or study carrels are available for users who are distracted by noise and movement around them	100	2.10	.577
	TOTAL / AVERAGE	**100**	**36.69**	7.422

- From the above table, it is found that the Library services with respect to the Access to the Library Building are higher in case of the variables – "**Aisles are kept wide and clear for wheelchair users" (M = 2.68), "Parking areas, pathways, and entrances to the building are wheelchair-accessible" (M = 2.66)** and "**Service desks and facilities such as book returns are wheel chair accessible"(M = 2.65)** when compared with others.
- From the above table, it is also inferred that Library services with respect to the Access to the Library Building are at the below average level since all Mean values of the variables are between 1.84 and 2.68 out of 5.
- The overall mean value of the Library Services – Access to the Library Building is 36.69. This is above 43% (36.69/85 x 100).

Table No. 10 Contribution Of Library Staff For Physically Challenged Students

Sl.No.	Description	N	Mean	SD
1.	Staff are aware of disability issues	100	2.20	1.263
2.	Staff are trained in use of telecommunication devices for the deaf (TDD / TTY) and adaptive computer technology provided in the library.	100	1.98	1.063
3.	Staff are trained in policies and procedures for providing accommodations to students with disabilities	100	2.01	1.087

Sl.No.	Description	N	Mean	SD
4.	**Staff are aware of services provided for the Physically Challenged students.**	**100**	**3.67**	**.829**
5.	Staffs have knowledge about other organizations, such as NGOs, Talking books and Braille libraries that provide information services to Physically Challenged students	100	3.49	.882
6.	Staff are provided with large print named badges	100	3.51	.882
7.	**Staff members with sign language skills are identified from other staff members to assist students who are deaf.**	**100**	**3.66**	**.829**
8.	**Staff are descriptive to guide the students with Visual impairments**	**100**	**3.86**	**.725**
9.	Staff face the students with hearing impairments and speak clearly when they talk to them	100	3.60	.791
10.	Staff read the instructions to students with some specific learning disability, if asked	100	2.59	1.443
11.	Staff try to sit in order to make level eye contact with students in wheelchairs when they interact	100	2.83	1.173
12.	Staff listen carefully and ask students with speech impairments to repeat what they have said if they don't understand	100	2.83	1.264
13.	Librarians are prepared to assist students with E-resources that they cannot access by providing research consultations or materials in other formats	100	3.02	1.318
	TOTAL / AVERAGE	**100**	**39.26**	**10.241**

- From the above table, it is found that the Library services with respect to the Library Staff are higher in case of the variables – "**Staff are descriptive to guide**

the students with Visual impairments" (M = 3.86), "Staff are aware of services provided for the Physically Challenged students" (M = 3.67) and "**Staff members with sign language skills are identified from other staff members to assist students who are deaf"(M = 3.66)** when compared with others.

- From the above table, it is also inferred that Library services with respect to the Library Staff are at the above average level since all Mean values of the variables are between 1.98 and 3.86 out of 5.
- The overall mean value of the Library Services –Library Staff is 39.26. This is above 60% (39.26/65 x 100).

Table No. 11 General Library Services To The Physically Challeged Students

Sl.No.	Description	N	Mean	SD
1.	The library provides awareness on the facilities and assistance available for the Physically Challenged students	100	3.54	.989
2.	Printed library information and assistance suited to the needs of Physically Challenged students in alternative formats are provided	100	3.35	1.058
3.	The library provides alternative delivery methods for students who are unable to visit the premises (home delivery – via mobile library or postal service)	100	3.40	1.035
4.	**Reader and research assistants are available to the students with vision impairments**	**100**	**3.61**	**.952**
5.	**Large magnifying glasses are available for students with low vision**	**100**	**3.70**	**.948**
6.	Sign language interpretation services are provided	100	3.44	.957
7.	Applications for nationwide network of Talking Book and Braille Libraries available for print	100	3.34	1.017
8.	Reference and Circulation services are available by phone, TTY / TTD and E-mail	100	3.46	1.058

Sl.No.	Description	N	Mean	SD
9.	Loans/fines/charges policies are flexible enough to reflect the fact that students with disabilities may require a more customized service	100	3.38	1.033
10.	Instruction manuals on the use of assistive technology are available in alternative formats	100	3.37	1.060
11.	The Policies and procedures for the disabilities are advertised in the library and library publications	100	3.51	1.040
12.	**Web based library services are provided to the Physically Challenged students**	**100**	**3.75**	**.947**
13.	Receipt system is established for printing and photocopying for scholarship/allowance purpose	100	3.40	1.025
14.	Loan system for laptops and peripherals is established	100	3.34	1.017
15.	Library services are marketed effectively to individuals and groups with disabilities	100	1.80	.816
16.	internal or external digitization services are offered to provide copies of material not available electronically	100	1.77	.863
17.	Term loan borrowing privileges are available	100	1.99	1.202
18.	Library collections are generally reflected the interests and experience of users with disabilities	100	2.06	1.213
19.	The library catalogue (including OPAC) is accessible to all	100	2.12	1.066
20.	Well organized Issue-Return Services are available	100	2.47	1.344
	TOTAL / AVERAGE	**100**	**60.80**	**16.044**

- From the above table, it is found that the General Library services for the Physically Challenged students are higher in case of the variables – "**Web based**

library services are provided to the Physically Challenged students" (M = 3.75), "Large magnifying glasses are available for students with low vision" (M = 3.70) and "**Reader and research assistants are available to the students with vision impairments"(M = 3.61)** when compared with others.

- From the above table, it is also inferred that General Library Services are at the above average level since all Mean values of the variables are between 1.77 and 3.75out of 5.
- The overall mean value of the Library Services –Library Staff is 60.80. This is above 60% (60.80/100 x 100).

FINDINGS

Library services with respect to the Library Policies for the Physically Challenged students in Arts and Science College are at the average level. Access to the Library Building are at the below average level. Library staff agreed that majority of the hardware devices and Software is not available for the usage in libraries to the Physically Challenged students.

CONCLUSION AND RECOMMENDATIONS

There should be a written policy for the library services to the Physically Challenged students in the college libraries. Every college Library should establish a Committee for Decision Making headed by Principal, senior faculty member and Physically Challenged student's representative to find out the requirement of the other Physically Challenged library users. The Policies and procedures for the disabled users are to be informed through Library Bulletin and other Library Publications. The policies for Loans / Fines/ Charges should be flexible enough to provide the students with disabilities customised services. It is suggested to provide accommodation for all the disabled students**.** It is suggested that library building should be on the ground floor close to the class rooms with sufficient parking spaces marked with the international symbol for the disabled, parking close to the library entrance. Clear and easy to read signposting, unobstructed and well lighted access paths to the entrance, smooth and non-slip surface at the entrance. Library should have directional signs also in Braille Format. Library should provide quite study / rest area for the disabled students. Library should have lifts in working condition.

Librarians and other Library Staff should be approachable, aware of the needs of the special students and willing to provide the students with the required materials in a required format. Library Staff need to continue being helpful and liaise with other colleges and relevant organizations to establish methods of best practices, to make the library services accessible

to the Physically Challenged students. Orientation and Training Programmes should be conducted on a regular basis to keep the Physically Challenged students updated about the latest technologies.

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Microsoft Power BI Desktop: A Versatile Tool for Data Visualization in Libraries with special reference to PSG College of Technology Library

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Abstract

Microsoft Power BI Desktop is a powerful tool for data visualization, offering extensive capabilities for libraries to analyse and present data effectively. This paper explores the role of Power BI Desktop in libraries, highlighting its features, benefits, and applications with special reference to PSG College of Technology Library. In today's data-driven environment, efficient data management and visualization are critical for informed decision-making. This paper discusses the advantages and limitations of Power BI Desktop and offers best practices for its implementation and also delves into its applications in academic libraries, particularly in collection analysis, user engagement, space planning, and assessment.

Keywords: Microsoft Power BI Desktop, data visualization, libraries, data transformation, collaboration, collection analysis.

INTRODUCTION

Data plays a crucial role in decision-making across various sectors, including libraries. With the exponential growth of digital data, effective data management and analysis have become essential. Libraries collect vast amounts of information related to resource usage, user behavior, and operational efficiency. Data visualization tools like Microsoft Power BI Desktop enable librarians to interpret and present data effectively, facilitating data-driven decisions. This paper discusses the significance of Power BI Desktop in libraries and how it enhances data-driven decision-making.

Microsoft Power BI Desktop is a powerful software tool for data visualization that is widely used by data analysts, business analysts, and data scientists. It provides a user-friendly interface that enables users to connect to a wide range of data sources, transform data, and create interactive and professional-looking visualizations. With its intuitive drag-and-drop interface, Power BI Desktop allows users to quickly and easily create charts, graphs, and other visualizations that can be used to identify patterns, trends, and insights in data. Additionally, Power BI Desktop provides a wide range of collaboration and sharing features, making it easy for teams to work together on data analysis projects. Generally, Microsoft Power BI Desktop is a versatile and effective tool for anyone looking to visualize and analyse data.Power BI Desktop provides a range of powerful features for analyzing and visualizing data, making it an ideal tool for business analysts, data scientists, and other professionals who need to work with data on a regular basis.

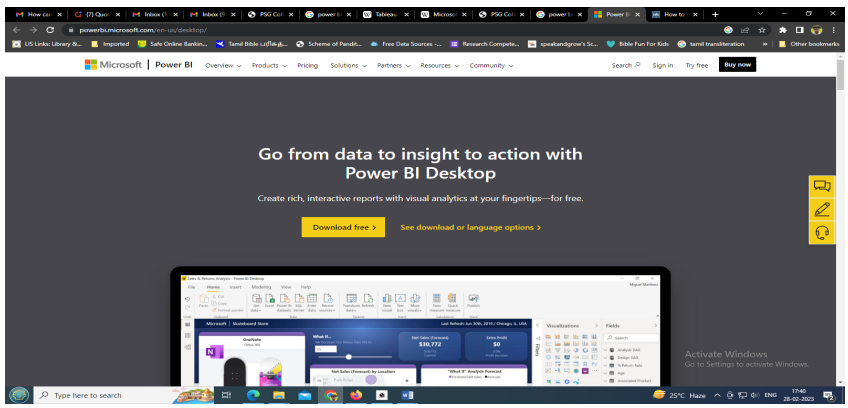

Figure 1: Microsoft Power BI Homepage

About PSG College of Technology

The PSG College of Technology, Dr GRD Memorial Library, located in Coimbatore, Tamil Nadu, is a pivotal resource center that supports academic and research activities across various disciplines. Established with a vision to provide seamless access to scholarly information, the library is a modern facility that caters to students, faculty, and researchers of the institution. The library is housed in a spacious, well-structured building and provides a conducive learning environment through its comprehensive collections and technology-driven services. It is well-organized into various sections such as the Reference Section, Circulation Section, Digital Library, Periodicals Section, and Reading Halls.It holds a vast repository of resources, including:

- Over one lakh volumes of books
- Numerous national and international journals
- A rich collection of e-books, e-journals, and conference proceedings
- Technical reports, theses, and dissertations

APPLICATION OF ICT IN DR GRD MEMORIAL LIBRARY

The PSG College of Technology library has effectively integrated modern **ICT (Information and Communication Technology)** tools to enhance the accessibility, usability, and efficiency of library services.The library operations are fully automated using Koha – an open-source integrated library management system (ILMS).All functions such as acquisition, cataloging, circulation, and serials control are managed digitally.The OPAC (Online Public Access Catalogue) enables users to search the library collection from any location.The library hosts a dedicated Digital Library Section, providing access to thousands of e-resources.It subscribes to major academic databases like IEEE Xplore, SpringerLink, ScienceDirect, and DELNET. Students and faculty can access e-books, e-journals, and digitized academic content through campus-wide LAN, Wi-Fi and remote login facilities.

To streamline book circulation and inventory management, the library has adopted RFID (Radio Frequency Identification) technology. RFID tags are embedded in books for faster check-in/check-out and theft prevention.Self-service kiosks allow users to issue and return books independently.The library supports e-learning platforms and provides access to NPTEL video lectures, online tutorials, and multimedia content.Dedicated computer terminals and Wi-Fi-enabled study areas facilitate online learning and research.The library manages an institutional repository to archive and provide open access to faculty publications, student theses, and project reports.This supports knowledge sharing and enhances the visibility of the institution's academic contributions.A dynamic and informative library portal offers updates on services, new arrivals, and tutorials on accessing digital resources.Online helpdesk and chat support assist users in resolving queries in real-time.

REVIEW OF LITERATURE

Becker and Gould (2019) examined Power BI's role in data manipulation and visualization, emphasizing its superiority over Excel in handling large datasets. Their survey indicated that Power BI enhances efficiency in data analysis and visualization.Bhargava, Kiran, and Rao (2018) explored the application of Power BI in educational institutions, demonstrating its effectiveness in visualizing student performance and institutional data. Their findings highlight

the tool's value in simplifying complex datasets.Ramadhan et al. (2022) assessed student satisfaction with Power BI at Bina Nusantara University, finding high usability and user loyalty. Their study underscores Power BI's relevance in educational settings.Smith and Taylor (2020) discussed the importance of data visualization in academic libraries and how tools like Power BI enhance decision-making by simplifying complex datasets.Johnson et al. (2021) analyzed the adoption of business intelligence tools in higher education, emphasizing Power BI's role in institutional planning and assessment.Wang and Chen (2019) provided insights into how academic institutions leverage Power BI to enhance student performance analysis and resource allocation.

IMPORTANCE OF DATA VISUALIZATION

Data visualization simplifies complex information, enabling users to identify trends, patterns, and insights. In libraries, visualization tools assist in analyzing resource usage, optimizing collection management, and improving user engagement. Interactive dashboards provide a dynamic way to present data, ensuring accessibility and comprehensibility for decision-makers.

MICROSOFT POWER BI DESKTOP: OVERVIEW

Microsoft Power BI Desktop is a robust data visualization tool used by analysts and librarians for data exploration. It features an intuitive drag-and-drop interface that allows users to create interactive reports and dashboards. Microsoft Power BI Desktop is a powerful software tool for data visualization that is widely used by data analysts, business analysts, and data scientists. It provides a user-friendly interface that enables users to connect to a wide range of data sources, transform data, and create interactive and professional-looking visualizations. With its intuitive drag-and-drop interface, Power BI Desktop allows users to quickly and easily create charts, graphs, and other visualizations that can be used to identify patterns, trends, and insights in data.

Power BI Desktop also provides a range of visualization tools, including charts, tables, maps, and gauges. These tools allow users to create interactive and compelling visualizations that help to convey insights more effectively. Power BI Desktop uses the DAX language, a formula language for data analysis and modelling, which enables users to perform complex calculations and data manipulations.Power BI Desktop also includes a query editor, which allows users to transform and clean data using Power Query, an advanced data manipulation tool. This tool makes it easy to clean, shape, and enhance data, as well as to perform more advanced data manipulations, such as pivoting and unpivoting data, merging and appending data, and filtering and sorting data.

Key functionalities of Power BI

- **Data Connectivity that s**upports various data sources such as SQL Server, Excel, and SharePoint.
- **Data Transformation which e**nables data cleansing, merging, and manipulation.
- **Visualization Tools that has p**rovide diverse charts, graphs, maps, and gauges.
- **Dashboard Creation that**allows users to build custom dashboards for performance monitoring.
- **Collaboration and Sharing that f**acilitates report sharing through cloud integration.
- **Advanced Analytics has the provision i**ncludes forecasting, clustering, and sentiment analysis capabilities.

IMPLICATION OF POWER BI AT PSG COLLEGE OF TECHNOLOGY LIBRARY

A Power BI dashboard developed for Dr GRD Memorial Library, PSG College of Technology provides insights into book transactions and visitor statistics. Power BI Desktop can be a valuable tool for academic librarians who want to use data to improve their services, resources, and user engagement. By providing easy-to-use data visualization tools and powerful data analysis capabilities, Power BI Desktop can help librarians make more informed decisions and demonstrate the value of the library to stakeholders.

The follow key visualizations include

- **Book Issue & Return Statistics which t**racks borrowing trend, peak usage periods, and membership trends.
- **Visitor Statistics that d**isplays year-wise and month-wise visitor patterns.
- **Book Statistics provide c**ategorizes books by publisher, subject, and material type.
- **Department-wise Transactions which helps to do micro level analyses** such as book transactions across different academic departments.
- Identifies leading publishers based on material availability.
- Highlights frequently borrowed books based on department and user category.

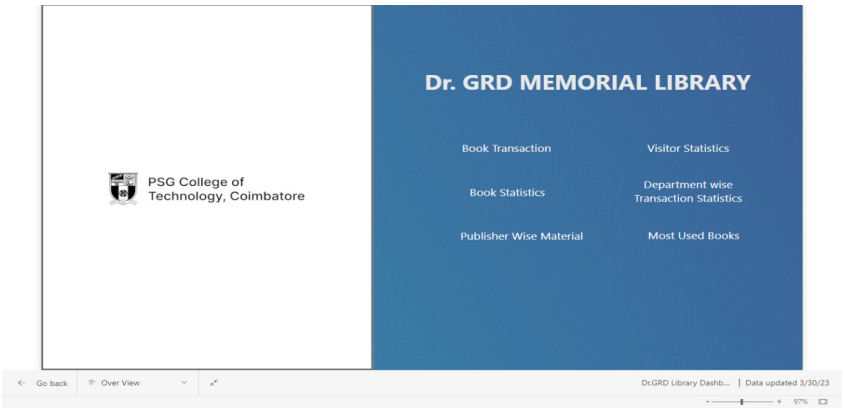

Figure 2: Power BI Desktop Version Dashboard

The given details pertain to a dashboard created using Power BI Desktop version for Dr GRD memorial Library, PSG College of Technology, which provides insights into book transactions and statistics. The dashboard displays information such as publisher-wise materials, visitor statistics, department-wise transaction statistics, and most used books. By segmenting statistics by publisher and department, the dashboard provides more targeted insights into book sales and helps inform purchasing decisions. The inclusion of visitor statistics can also provide insights into the effectiveness of the library or bookstore. The dashboard likely uses data from a database or other source to provide up-to-date information book transactions and statistics, and could prove to be a valuable tool for those in the book industry.

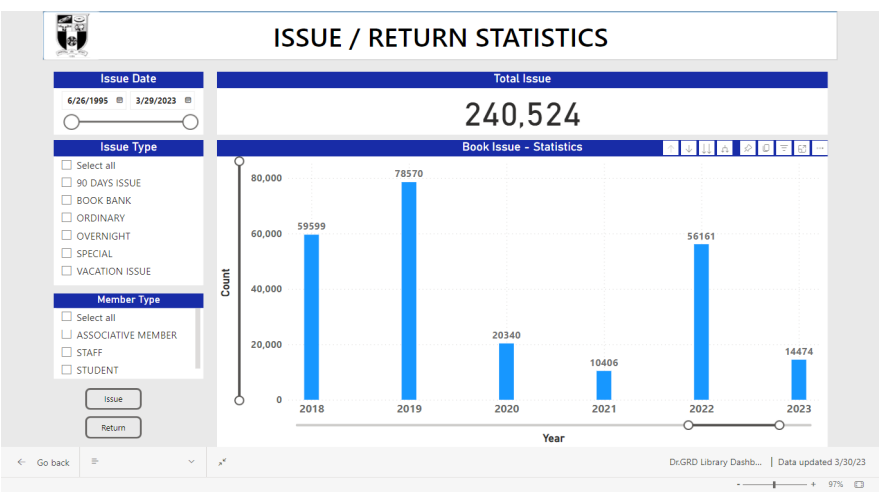

Figure 3: Book Issue Return Statistics

The Figure 3 Book Issue Return Statistics provides a comprehensive overview of borrowing habits and trends, including total issues, issue type, members type, and issue date. By analysing this data, bookstores and libraries can identify popular books, active borrowers, and peak borrowing periods. This information can be used to optimize inventory management, marketing strategies, and overall operations, providing a better borrower experience and increasing revenue. Ultimately, the insights gained from Figure 2's book issue and return statistics can help inform purchasing decisions and lead to success in the highly competitive book industry.



Figure 4: Visitor Statistics

Figure 4 provides visitor statistics for a given dataset, which has been filtered and categorized by material type. The data is presented in both year-wise and month-wise formats. The figure displays the total count of visitors for each category and time period, highlighting any significant trends or changes in visitor behaviour over time. This figure provides valuable insights into the usage patterns of the given dataset and can inform decisions related to resource allocation and future development.

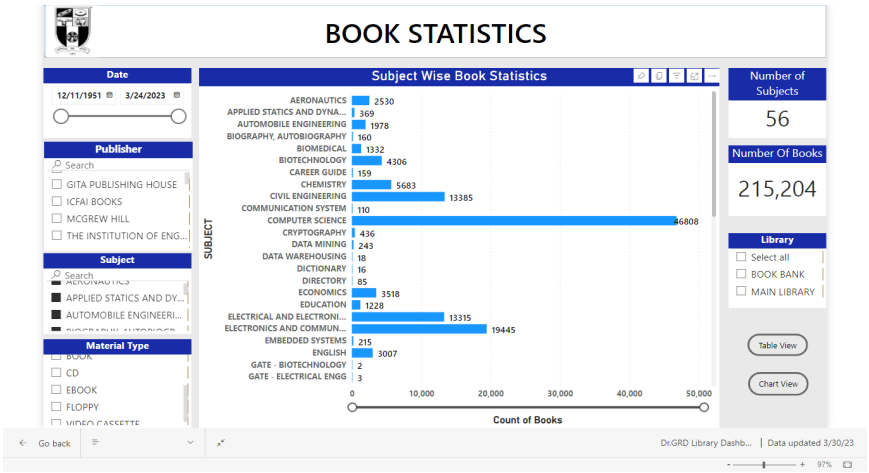

Figure 5: Book Statistics

Figure 5 presents book statistics for a given dataset, which has been filtered by date and categorized by publisher, subject, and material type. The figure provides both a table and chart view of the data, allowing for easy visualization of the number of subjects, books, and library categories within each category. The figure also highlights any significant trends or changes in book usage over time. This figure provides valuable insights into the popularity and distribution of books within the given dataset and can inform decisions related to collection development and resource allocation.

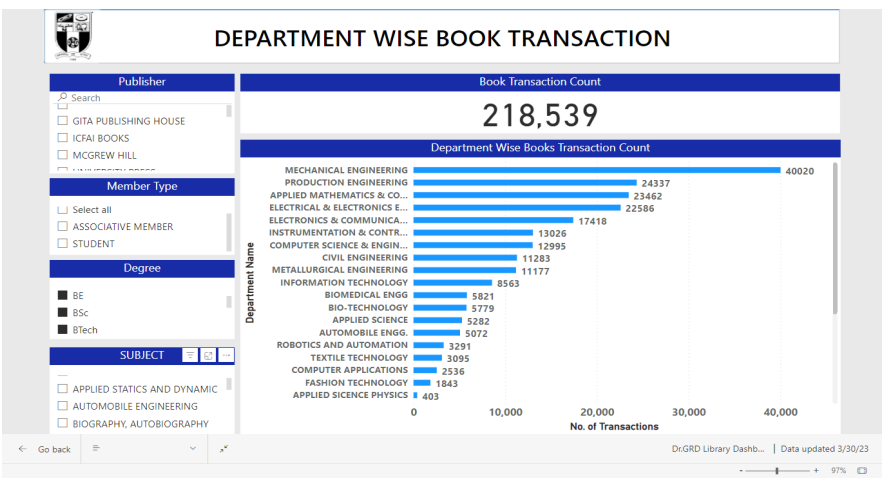

Figure 6: Department wise Book Transaction

Figure 6 displays department-wise book transaction counts for a given dataset, which has been filtered by publisher, member type, degree, and subject. The figure provides valuable insights into the usage patterns of books within different departments and highlights any significant differences in book transactions between departments. The publisher filter allows for a closer examination of the usage of books from specific publishers, while the member type and degree filters provide information about the types of users who are accessing the books. The subject filter helps to identify the most popular subjects within each department. This figure can inform decisions related to resource allocation and collection development within different departments based on their specific usage patterns.

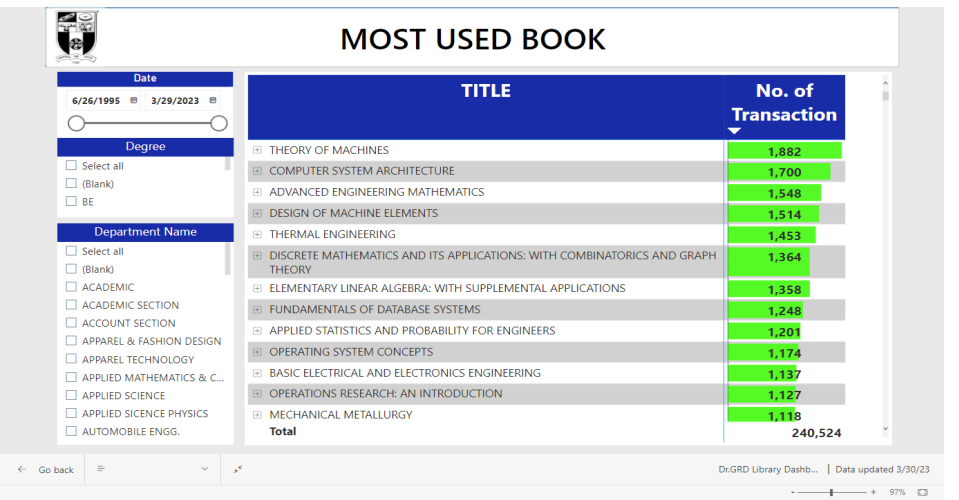

Figure 7: Frequently used books

Figure 7 presents a list of the most used books for a given dataset, filtered by date, degree, and department name. The figure displays the titles of the most used books along with the number of transactions for each book. This information can be useful in identifying the most popular books within a given dataset, as well as understanding the reading habits of users within specific departments and degree programs. The date filter allows for an examination of the most popular books within a specific time frame, while the degree and department filters help to identify the books that are most relevant to particular user groups. This figure provides valuable insights into the usage patterns of books within a given dataset and can inform decisions related to collection development and resource allocation.

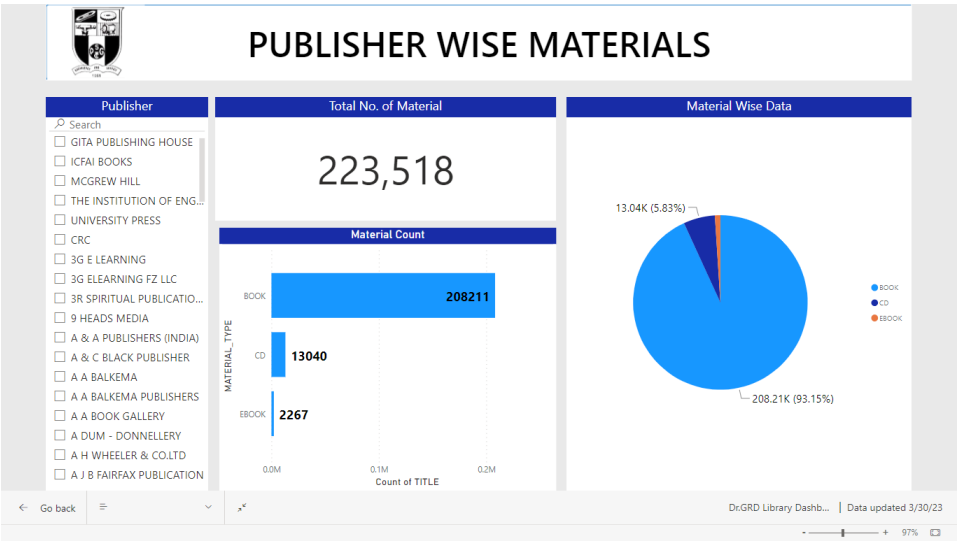

Figure 8: Publisher Wise Materials

Figure 8 presents publisher-wise material counts for a given dataset. The figure displays the total number of materials published by each publisher and categorizes the materials by type. Additionally, the figure provides a pie chart that breaks down the material counts by type. This information can be useful in identifying the publishers that produce the most materials within a given dataset and the types of materials that are most common. This can inform decisions related to collection development and resource allocation, as well as provide insights into the trends in publishing within the given dataset. This figure provides a useful overview of the distribution of materials within a given dataset and can inform decisions related to library management and development.

CHALLENGES IN USING POWER BI DESKTOP

While Power BI Desktop is a powerful tool, users may face several challenges such as cleaning and structuring data can be time-consuming., mastering data modeling and DAX formulas requires effort, large datasets may affect processing speed, more over advanced features require paid licenses and some visualizations may require additional programming expertise.

CONSTRAINTS ON IMPLEMENTATION AT PSG COLLEGE OF TECHNOLOGY

There arecertain **constraints and challenges** from both the **staff and user**perspectives. Lack of technical expertise among some library staff to operate and maintain advanced ICT systems like Koha, RFID, or digital repository platforms.Continuous need for professional development and training programs to keep up with evolving technologies.Some long-serving staff may show resistance to transitioning from manual to digital systems due to familiarity with traditional workflows.Fear of job redundancy or increased workload during the transition phase.Limited in-house technical personnel to troubleshoot and maintain complex ICT systems.Dependence on external vendors for support can lead to delays in issue resolution. Initial investment in RFID systems, high-end servers, and subscription databases may strain library budgets.Ongoing costs for software updates, maintenance, and staff training may not always be feasible.

Some users (especially first-year students or those from rural backgrounds) may lack adequate digital literacy to utilize online catalogues, e-resources, or self-service kiosks efficiently.Need for regular orientation programs and user education sessions.Inconsistent internet access or bandwidth limitations, especially during peak usage times, can affect access to digital resources.Users without personal devices may face difficulty accessing e-resources outside of library hours.Preference for physical books and human interaction in traditional setups.Lack of interest or willingness to explore newer tech-based services without guidance. With abundant digital content available, users may find it overwhelming to locate relevant and authentic information without proper search skills.

CONCLUSION

Microsoft Power BI Desktop is a valuable tool for academic libraries, offering powerful data visualization and analysis capabilities. Power BI Desktop provides a user-friendly interface for connecting, transforming, and visualizing data in real time. This paper examines its key functionalities, including data integration, transformation, visualization tools, and collaborative features with the special reference to PSG College of Technology, Coimbatore.It enables librarians to make informed decisions regarding resource allocation, user engagement, and space management. With the support of Power BI, libraries can enhance their services, optimize operations, and demonstrate their impact effectively.

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Advancing Library Services with Beacon Technology for a Sustainable Future

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Abstract

Beacon technology is transforming the way libraries interact with patrons by enhancing user experience, optimizing resource management, and improving accessibility. Beacons, which use Bluetooth Low Energy (BLE), enable libraries to provide personalized services, location-based notifications, and real-time navigation assistance. This paper explores the impact of beacon technology in libraries, its applications, benefits, challenges, and future prospects.The study examines how beacon technology aligns with energy-efficient and eco-friendly practices to modernize libraries. This article also discusses the advantages, challenges, and strategies for successful implementation while adhering to sustainable development goals.

Keywords: *Beacon Technology, Bluetooth Low Energy (BLE), Sustainability, Data Analytics in Libraries, Library Innovation*

INTRODUCTION

Libraries have traditionally been information bases and hubs for education and cross-cultural interaction. Libraries must adjust to changing organizational goals brought about by changing user expectations and environmental concerns in this digital age. In this evolution, sustainability has emerged as a major concern, necessitating that libraries implement energy-efficient procedures and minimize resource waste. Beacon Technology and other technological

developments present a possible route to accomplishing these objectives. As an illustration of how eco-friendly practices can coexist with cutting-edge technologies, the Singapore Management University Library reported a 20% decrease in paper usage following the implementation of beacon-enabled devices for notifications and resource tracking.Beacon technology a relatively recent innovation offers libraries the opportunity to merge technological advancement with sustainable practices. These compact BLE based devices can transmit data over short distances, enabling features like indoor navigation, resource tracking and real time user engagement. By offering eco-friendly and user centric solutions beacons can help libraries meet the dual sustainability goals.

This paper explores the potential of beacon technology as a sustainable solution for enhancing library services and user engagement. Beacon technology, which uses Bluetooth Low Energy (BLE) to transmit signals to nearby devices, can transform traditional library environments into interactive, tech-driven spaces. The study provides a comprehensive analysis of its applicability in libraries, focusing on its key features, adaptability, operating system support, and implications for sustainability

BEACON TECHNOLOGY

Beacon technology is based on Bluetooth Low Energy (BLE), a wireless communication protocol designed for short-range data transmission. Beacons are wireless transmitters that use BLE to send signals to nearby devices. They are compact energy efficient and can interact with mobile devices with their range. Applications span multiple industries including retails, healthcare and editions. Beacons are small devices that emit signals detected by compatible mobile devices, triggering predefined actions as notifications or location tracking.

Libraries have long been at the forefront of adopting technological innovations to enhance user engagement and service delivery. With the rise of mobile devices and smart technologies, libraries are integrating beacon technology to offer a seamless and interactive user experience. Beacons, which use Bluetooth Low Energy (BLE), transmit signals to nearby devices, enabling personalized communication and navigation assistance. This paper examines how beacon technology is revolutionizing library services, making them more accessible, efficient, and user-friendly.

NEED OF BEACON TECHNOLOGY FOR LIBRARIES

- To Enhance user experience and to facilitates indoor navigation and personalized services

- To promote paperless communication and energy efficient operations as Sustainability goals
- To get real time analytics gathers insights into user behavior, helping optimize space and resource utilization

APPLICATIONS OF BEACON TECHNOLOGY IN LIBRARIES

Beacon Technology is used as path finder for location of books like Beacons help users navigate large libraries by providing real-time directions to specific sections, book locations, and facilities and Patrons can use mobile apps to receive step-by-step guidance, reducing the time spent searching for resources. Using this technology, Libraries can send location-based notifications to users about book availability, upcoming events, or overdue books and Personalized reading recommendations based on browsing history can be delivered to patrons in real time.

Beacons streamline check-ins and checkouts by integrating with library management systems, reducing manual processes and also users can receive automatic notifications when they enter or leave the library, confirming attendance at scheduled sessions or study rooms. It helps to provide enhanced user engagement such as Interactive exhibits and digital storytelling experiences can be created using beacon-triggered multimedia content and libraries can conduct scavenger hunts or gamification initiatives to encourage learning and exploration. Beacon technology facilitates Beacons track foot traffic patterns to optimize space utilization and seating arrangements and Libraries can collect data on visitor behavior to improve service offerings and facility management.

RELATED WORKS

Kamarudin and Mahmud **(2022).**Reviewed the role of proximity based technologies including beacons in delivering personalized services in libraries. Their findings suggest that beacons enhance user satisfaction by providing real time notifications about library events, book availability, and location based guidance. These features bridge the gap between traditional and digital library services, fostering interactive leaning spaces.***Chen and Chen (2023).*** Analyzed beacon technology's low energy consumption a a sustainable alternative to traditional library management systems. They argue that BLE devices reduce the environmental footprint of libraries by minimizing paper usage for communication and facilitating energy efficient operations. ***Smith and Taylor (2023).***Highlighted the adaption of beacon technology in smart libraries emphasizing its ability to optimize resource management. Beacons enable automated books check-ins notifications for overdue returns and indoor navigation for

locating bookshelves or study areas. This contributes to operational efficiency and aligns with libraries' goals of embracing technological innovation.**Patel et al (2020*).*** Outlines barriers such as initial setup costs privacy concerns due to user data tracking and dependence on users having compatible devices. Libraries need to address these issues through transparent policies and cost-effective solutions.

PREREQUISITES FOR IMPLEMENTING BEACON TECHNOLOGY IN LIBRARIES

Before deploying beacon technology in libraries, certain prerequisites must be met to ensure seamless integration and optimal performance

Libraries must install BLE beacons strategically across various sections to facilitate real-time communication with user devices and the placement of beacons should be carefully planned to avoid signal interference and ensure accurate location tracking.Users need a mobile application that can interact with the beacons. This app should support BLE and be compatible with iOS and Android devices and some libraries may integrate beacon services into existing library management apps.

Beacons should be integrated with the library's database and management system to offer real-time updates on book availability, overdue alerts, and personalized recommendations.

Beacons generate and transmit data, which needs to be processed and stored securely. Cloud-based storage and analytics platforms can help libraries manage and analyze data efficiently.Libraries must implement proper privacy policies and data protection mechanisms to safeguard user location data and prevent unauthorized access.BLE beacons require periodic battery replacements and software updates to ensure continued functionality.Some advanced beacons support energy-efficient mechanisms to extend battery life.

HOW BEACON TECHNOLOGY WORKS IN LIBRARIES

Beacon technology operates through **Bluetooth Low Energy (BLE)** signals that interact with nearby mobile devices. The working process is as follows:

Step 1 : Signal Transmission

Beacons continuously emit low-energy Bluetooth signals at regular intervals. These signals contain a unique identifier for each beacon.

Step 2 : Device Detection and Interaction:

When a user with a BLE-enabled mobile device comes within range, the mobile app detects the beacon signal.The app determines the user's approximate location based on signal strength and beacon proximity.

Step 3: Triggering Notifications and Actions:

Once the mobile app identifies a beacon's location, it triggers predefined actions such as:

- Sending location-based notifications
- Providing navigation assistance
- Delivering personalized content based on user preferences.

Step 4: Data Collection and Analysis:

Beacons collect anonymized user movement data, helping libraries analyze visitor traffic, optimize space utilization, and improve resource allocation.

Step 5 : Automation and Integration:

Beacons can be linked with self-checkout systems, study room bookings, and attendance tracking to automate routine tasks and advanced integrations with AI and IoT can enhance predictive analytics and improve overall user experience.

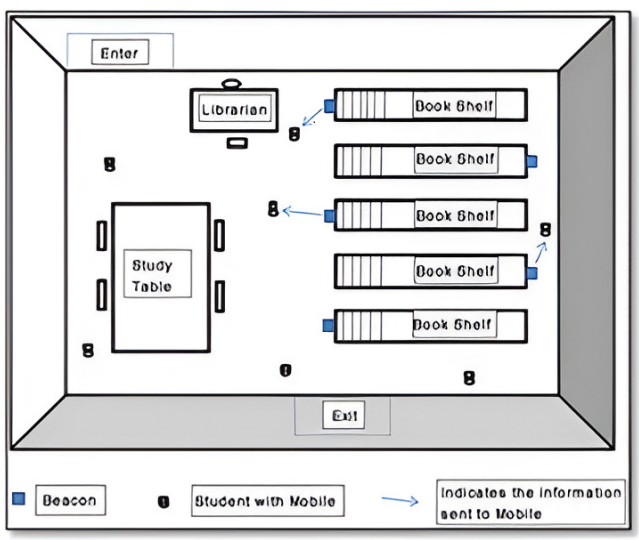

Figure 1 System structure block diagram of the Library

Figure 1 shows the system structure block diagram outlining the key components of the library's Beacon-enabled infrastructure. The beacons represented by Blue icons, are placed in key areas, such as bookshelves and study tables. These Beacons interact with students' mobile devices, providing real-time information about available resources and library facilities. The diagram shows how the mobile application and beacon system work together to ensure that students can access up-to-date information, locate book, and find available study spaces easily. This system enhances the overall experiences by making the library more interactive and user friendly.

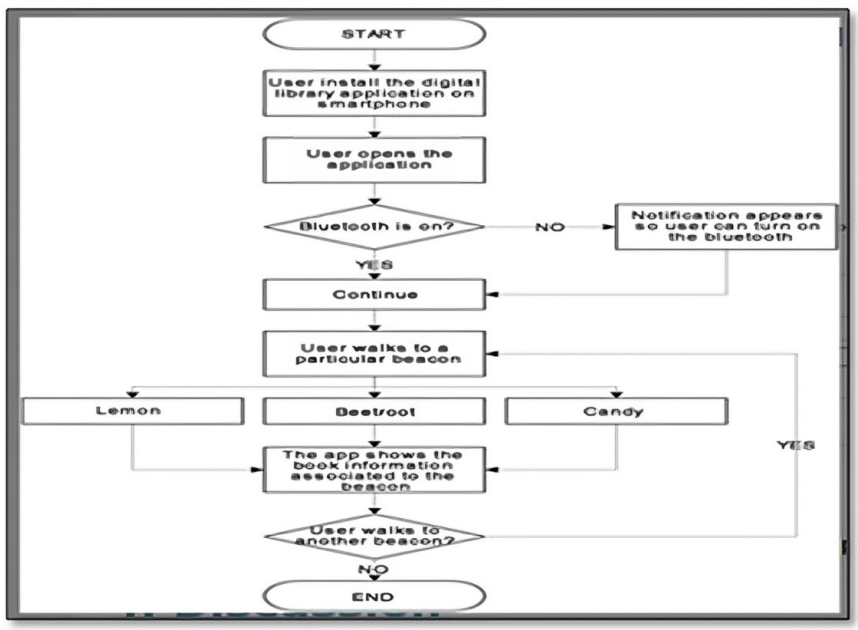

Figure 2 System structure block diagram of the library

Figure 2 shows that the system utilizes beacons (small devices with BLE) to provide information about books to users. The user starts by installing the digital application on their smart phones. The application checks if the Bluetooth is enabled on the user's device. If not it prompts the user to turn it on. The application scans for nearby beacons. If a beacon is detected the application displays a notification on the user's Smartphone screen, indicating the presence of a beacon. The user can choose to continue or ignore the notification. If the user continues, the application retrieves the book information associated with the detected beacon. The application displays the retrieved book information on the user's Smartphone screen. The process ends when the user closes the application or moves out of range of the beacon.

COMPARISON OF BEACON TECHNOLOGY WITH ALTERNATIVE SYSTEMS

Features	Beacon Technology	RFID	Wi-Fi Based Systems
Range	Short range (up to 50 Meters)	Longer than (Up to 100 for active tags)	Long rage (entire Wi-Fi network coverage)
Energy Efficiency	High (BLE)	Varies (active tags require battery power)	Moderate to high (depending on the setup)
User Interaction	Provides real-time notifications, navigation, and analytics	Primarily used for tracking items and inventory management	Provides internet access and can be used for location-based services)
Cost	Moderate (requires beacons and app development)	High (requires RFID tags and readers)	Moderate to high (requires routers and infrastructure)
Privacy Concerns	Moderate (data tracking, requires encryption and opt-in)	Low (no personal data tracking)	High (location tracking through IP addresses, data usage concern)
Installation Flexibility	Easy to install in existing infrastructure, mobile app integration	Requires specific infrastructure for readers and tags	Requires full network setup, can be more complex
Maintenance	Regular updates and battery replacements for beacons	Regular maintenance for active RFID tags	Ongoing maintenance of Wi-Fi network and routers

BENEFITS OF USING BEACON TECHNOLOGY

Beacons provideImproved Accessibility for visually impaired users with audio navigation assistance, ensuring inclusive library experiences, Enhancing the user experience by providing personalized recommendations and interactive features improve engagement and satisfaction. Beacons improves the operational efficiency like automation of check-ins, notifications, and tracking reduces staff workload and administrative overhead and helps to take data driven decision making in libraries by providing nsights from beacon-generated data help libraries optimize resource allocation and service improvements.

CHALLENGES IN IMPLEMENTING BEACON TECHNOLOGY

- Installing beacons and developing mobile applications require financial investment.
- Users may have reservations about data collection and location tracking.
- Patrons need Bluetooth-enabled devices and compatible applications for seamless interaction.
- Beacons require periodic maintenance, battery replacements, and software updates.

FUTURE PROSPECTS

As technology continues to evolve, beacon technology in libraries is expected to expand further. The integration of artificial intelligence (AI) and Internet of Things (IoT) with beacons can enhance personalization, automate services, and improve predictive analytics. Future libraries may adopt smart beacons with voice commands, AI-driven recommendations, and seamless interoperability with other smart systems.

CONCLUSION

Beacon technology offers a significant opportunity for libraries to improve their services while also promoting sustainability. By utilizing Bluetooth Low Energy (BLE), libraries can create personalized user experiences, simplify resource discovery, and enhance operational efficiency. The use of beacons can help minimize paper waste, provide real-time data analytics, and support energy-efficient practices, all of which align with the sustainability objectives of libraries. Beacon technology is a game-changer for libraries, offering innovative solutions to enhance user engagement, streamline operations, and improve accessibility. While challenges exist, the benefits outweigh the drawbacks, making beacon technology a valuable addition to

modern library ecosystems. As libraries continue to embrace digital transformation, beacons will play a crucial role in shaping the future of library services.Although there are challenges to consider, such as initial setup costs, privacy issues, and user adoption, the advantages of beacon technology greatly surpass these hurdles. The success of this technology will rely on careful planning, clear policies, and affordable solutions to tackle these challenges. Ultimately, beacon technology presents a bright future for libraries, allowing them to remain relevant, innovative, and environmentally conscious in a rapidly digitalizing world.

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Discovering and Curating Library Resources with VuFind: A Step-by-Step Guide

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Abstract

This paper explores the implementation of VuFind, an open-source library discovery system, at Dr. GRD Memorial Library, PSG College of Technology. VuFind enhances search efficiency by integrating books, journals, and digital collections into a unified, user-friendly platform. The study outlines the installation process, prerequisites, and customization required for seamless integration with existing library management systems. The research highlights VuFind's advanced search features, faceted searching, and personalization tools, improving resource discovery and accessibility. Additionally, the paper discusses the benefits, challenges, and maintenance requirements of VuFind, ensuring an optimized library experience for students and researchers. The findings demonstrate that VuFind enhances information retrieval while supporting scalability, accessibility, and collaborative library development.

Keywords: Vufind, Data Curation, Resource Discovery, Open source Tool

INTRODUCTION

VuFind is an open-source discovery system designed to facilitate efficient and user-friendly access to library resources. Developed for libraries and institutions, VuFind serves as a search interface that integrates with existing library systems, allowing users to discover and access a

wide range of materials, including books, journals, and digital content. It provides advanced search capabilities, personalized user features, and tools for managing and organizing search results. VuFind aims to enhance the user experience by offering a modern and intuitive interface, making it easier for patrons to explore and utilize the wealth of information available within a library's collection. Additionally, as an open-source project, VuFind encourages collaboration and customization, allowing institutions to tailor the system to their specific needs.IntegratingVuFind into Dr. GRD Memorial Library, PSG College of Technology, Coimbatore enhances search efficiency, providing a unified platform for books, journals, and databases. It offers a user-friendly interface, personalized accounts, seamless PSG-ILMS integration, and improved catalog management. As an open-source system, VuFind ensures cost-effective, scalable, and modernized library access for students and researchers.

This paper focus on the how to implement VuFind to improve the library's resource discovery capabilities through its advanced search features and efficient retrieval mechanisms. The way to customize the VuFind interface to user experience goals, providing a visual platform for patrons. This paper also explores the procedure to install and configure the Apache Solr search engine to enhance the speed, accuracy, and relevancy of search results within the VuFind platform and to facilitate advanced and efficient searching across various library resources, including books, journals, digital collections, and other materials.

About PSG College of Technology

PSG College of Technology, located in Coimbatore, Tamil Nadu, is a premier institution established in 1951 under the PSG & Sons' Charities Trust. It offers a broad spectrum of undergraduate, postgraduate, and doctoral programs in engineering, science, and management disciplines. Known for its academic excellence, strong industry collaboration, and innovation-driven education, PSG Tech is one of India's most respected engineering colleges.

The Dr. GRD Memorial Library at PSG College of Technology exemplifies how libraries can evolve into digital learning environments through ICT integration. With robust automation, rich digital content, and user-friendly services, the library stands as a cornerstone of PSG Tech's commitment to excellence in education and research.The Dr. GRD Memorial Library is a model of ICT integration in academic libraries with Fully automated library operations using Koha, an open-source ILMS and Implementation of Radio Frequency Identification (RFID) for fast and efficient self-issue and return of books via kiosks, anti-theft detection systems at entry/exit points, real-time inventory tracking of books and resources and modules for acquisition, cataloging, circulation, serials management, and patron services and Online Public Access Catalogue (OPAC) accessible within and outside the campus.

Dr GRD Memorial Library has dedicated access terminals for NPTEL (National Programme on Technology Enhanced Learning) video lectures, Support for SWAYAM and Coursera MOOCs, enhancing blended learning opportunities and VPN and remote login systems enable access to e-resources off-campus and Using EZproxy or Shibboleth for authenticated access. It also facilitates SMS and Email alerts for due dates, fines, and new arrivals.Interactive help desk and digital user guides for resource navigation and Online renewal, reservations, and feedback submission through the library portal.

REVIEW OF LITERATURE

Custer, W. (2020). Libraries increasingly seek to enhance their Online Public Access Catalogs (OPACs) to provide better searchability, usability, and customization, as traditional OPACs within Integrated Library Systems (ILS) often lack flexibility and user-friendly interfaces. VuFind, an open-source discovery layer developed by Villanova University, offers a customizable and efficient alternative, enabling libraries to improve indexing, aesthetics, and search functionalities. While VuFind allows greater adaptability, its implementation requires technical expertise, time, and resources for customization and integration with existing systems. Despite challenges, its affordability, active community support, and enhanced user experience make it a compelling choice for libraries aiming to modernize their discovery systems.

Bhowmick, A., &Chakrabarty, B. (2021). The paper explores the integration of open-source library systems, including Koha (ILS), Greenstone (Digital Library), and DSpace (Institutional Repository), with VuFind, an open-source discovery layer. It details the design, workflow, and integration methodology using standardized protocols to achieve a unified single-window search interface for metadata harvesting and full-text access. By leveraging open-source technologies, the study highlights how libraries can enhance resource discovery while significantly reducing costs compared to proprietary discovery systems, making it a viable alternative for institutions seeking affordable and customizable solutions.

Proskudina, G. Y., et. al. (2023).The article explores VuFind as an open-source solution for integrating diverse library collections, enhancing access to books, articles, journals, and reports. It highlights VuFind's key features, including customization, advanced search capabilities, metadata support, and multi-source integration. The system simplifies user searches and optimizes library collection management by offering a unified, modern discovery interface. Emphasizing its role in enhancing user experience and streamlining resource discovery, the study positions VuFind as a cost-effective, scalable alternative for libraries seeking efficient integration and improved accessibility.

Roy, B K., (2022) explored an overview of resource discovery systems and services, their benefits, best practices, and existing environments are given in this paper. It lists some of the main features and services of an all-inclusive discovery model that academic libraries in developing nations can use. Similar to other web-scale resource discovery systems that are now in use, both open-source and commercial, the suggested model (VuFind as a discovery tool) can provide information resources from many sources in a single-window search interface. Through its discovery interface, which is built on a single index, the paper aims to offer smooth access to geographically dispersed open access and subscribed resources. In addition to employing VuFind as a front-end discovery layer and Koha, DSpace, and Greenstone as back-ends, this architecture has numerous improved search features, such as Bento-box search, Geodetic search, and full-text search (using Apache Tika). This study aims to give the academic community a one-stop shop for using and integrating VuFind (https://vufind.org/vufind) with heterogeneous bibliographic data sources more effectively.

Widiastuti, I. (2022). The University of Jember Library adopted VuFind Web Scale Discovery Services (WSDS) to manage open-access e-resources efficiently. This study explores its implementation, enabling users to access multiple databases through a single indexed portal. Using a descriptive qualitative method with a case study approach, data was collected via observation, interviews, and document tracing. Challenges arose in harvesting and editing metadata due to variations across databases. Despite technical issues, results indicate that VuFind significantly enhances access to diverse open-access e-resources, improving library services.

VuFind Application for Libraries

VuFind installation in libraries offers a unified search interface by integrating catalogs, databases, and digital collections for seamless discovery. It enhances catalog records with enriched metadata, cover images, and user-friendly features while allowing customization and branding to align with institutional identity. Advanced search options like faceted searching and relevance ranking improve search efficiency, while integration with library systems ensures smooth backend operations. VuFind supports accessibility, resource sharing, and user engagement through personalization features like saved searches. Mobile compatibility ensures usability across devices, and analytics tools provide insights into user behavior. As an open-source platform, VuFind improvises community collaboration, enabling continuous improvement and innovation in library services.

Working Mechanism- Step by Step

Step 1: Install VuFind – Begin by installing the **VuFind – Search, Discover, and Share** open-source software.

Step 2: Set Up Prerequisites – Install and configure essential components such as web server (commonly Apache), PHP, Java, and MariaDB. Additionally, integrate **Apache Solr**, the search engine used by VuFind.

Step 3: Configure Basic Settings – Set up **cache, database, NoILS, Solr,** and security configurations for proper system functionality.

Step 4: Import MARC File – Log in using the institution's email ID, then import the **MARC** file into VuFind via the terminal.

Step 5: Search and Discover – Access **localhost/VuFind**, search or browse using keywords, and view the imported items displayed on the screen.

IMPLEMENTATION OF VUFIND AT DR. GRD MEMORIAL LIBRARY

Below are the steps involved in the implementation of VuFind in the academic library for resource sharing, catalog records, and discovery and easy retrieval of resources.

Step 1: Installation of Ubuntu

Step 2: Installation of Prerequisites

Step 3: Installation of VuFind

Step 4: Configuration of basic things

Step 5: Creation of an account in VuFind

Step 6: Conversion of bibliographic data into MARC

Step 7: Import the MARC file into VuFind

Step 8: Searching of Resources

Step 9: Implementation of VuFind for the patron usage

Step 10: Regular updates on VuFind

The following steps provide a detailed explanation and offer hands-on experience in working with VuFind, a discovery tool.

Step 1: Installation of Ubuntu

VuFind is a discovery tool used in libraries. This tool was developed by the libraries for the libraries. The resources were quickly discovered and easily retrieved through the VuFind. It is open source software. So, it would be comparable easily with an open source operating system. For that purpose, I selected Ubuntu, which is an open-source software. Next users can install Ubuntu OS. Ubuntu, developed by Canonical Ltd., is a user-friendly, secure, and stable Linux-based OS supporting desktops, servers, and cloud computing. With a GNOME interface, regular updates, and vast software support, it's ideal for individuals, enterprises, and educational institutions.

Step 2: Prerequisites for installation of VuFind

This step deals with the prerequisites of VuFind installation on the Ubuntu operating system. They are,

- Good condition System with high internet speed
- Ubuntu Operating System
- For a small index very basic web server hardware will be sufficient. (probably **around 2GB of RAM** and a few GBs of disk storage)
- Solr (It is a search server)

SOFTWARE PREREQUISITES

Softwares	VuFind	Apache HTTP Server	PHP	MySQL	Java JDK
Version(s)	VuFind 9.0.x	2.4+	7.4.1+	5.7.8+ (or MariaDB 10.2.7+)	11+
	VuFind 9.1+	2.4+	8.0+	5.7.8+ (or MariaDB 10.2.7+)	11+

Step 3: Installation of VuFind

The Ubuntu operating system will install anything through the command. The user can type the command in the terminal. Open terminal by right-clicking on the desktop and clicking on the "Open in terminal" option, and then the terminal would be open.Then users can search for the command of VuFind installation on any search engine. Select the appropriate link to install VuFind, here we have used this following source https://subratiitk.wordpress.com/install-vufind-on-ubuntu/

INSTALLATION PROCESS OF VUFIND

Then the user can run the above command one by one in the terminal, which help the user to install VuFind in the system. In the terminal, run the previous command, "**sudosu"** and enter the password of the Ubuntu, and then press the enter key.Before any installation, the user must update the system by running this command "**sudo apt-get update**". Then upgrade the system by running the command "**sudo apt-get upgrade**". **'gedit'** will be a reliable tool to accomplish your task. Its flexible plugin system allows you to tailor the application to your needs and adapt it to your workflow. Install the gedit by using the command "**sudo apt-getinstallgedit**".

Apache uses PHP to turn VuFind's code into web pages customized to answer user requests. Next user can install the Apache through the command "**sudo apt-get -y install apache2"**. Then rewrite the apache by using the command "**sudo a2enmod rewrite**".Next, the user can run the command "**sudo /etc/init.d/apache2 force-reload"** to reload it in the force mode.

Mariadb stores all the resources, backup files in this server. Users can install MariaDB through the command "**sudo apt install mariadb-server".**Then the user can assign the root password. Assign the password of root by using the command "**sudomysqladmin -u root password newpass**[Replace 'newpass']". Users can edit or change the password to become the last word in the command.

PHP is the programming language that was used to write VuFind. Apache uses PHP to turn VuFind's code into web pages customized to answer user requests. PHP is the engine that drives all of VuFind's interactivity; without it, VuFind wouldn't be able to do anything. User can install PHP through the command "**sudo apt-get -y install libapache2-mod-php php-mbstringphp-pear phpphp-dev php-gdphp-intlphp-jsonphp-ldapphp-mysqlphp-xml php-soap php-curl".**Then the user can also install the php-sybase by using the command "**sudo apt-get -y install php-sybase".**

Next install **JDK (the Java Development Kit)** on the server – VuFind searching back-end and MARC indexing tools rely on Java. Note that some VuFind components may be able to run using only the **JRE (Java Runtime Environment)**, but the JDK is strongly recommended and required for proper MARC indexing after release 3.1. Users can install Java JDK through the command "**sudo apt-get -y install default-jdk**".

Next the user can download the VuFind by using the command following steps. Change the directory by using the command "**cd /tmp**". The name **tmp** is a directory.Then download the VuFind tar.gz file by using the command "**wgethttps://github.com/vufind-org/vufind/releases/download/v9.0.3/vufind-9.0.3.tar.gz**". Users can edit or change the version of VuFind according to the latest version of the software. Then the user can unzip the file that was downloaded as "**vufind-9.0.3.tar.gz**" using the command "**tar -xzvf vufind-9.0.3.tar.gz**", then move to the folder named as "**usr/local/vufind**" using the command "**sudo mv vufind-9.0.3 /usr/local/vufind".**

Now, come to the step of installation of VuFind. First change the directory to **usr/loal/vufind**. Run the command "**cd /usr/local/vufind**" to change the directory.Once again install the php by using the command "**phpinstall.php**".

Then the terminal shows the message "**Where would you like to store your local settings? [/usr/loal/vufind/local]**". After that, click the "**Enter**" button.

Next, the terminal asks for the module name as "**What module name would you like to use? [Blank for none]**". Here, I leave the name blank and press the "**Enter**" button. Then the terminal shows "**What base path should be used in VuFind' URL? [/vufind]".** This is the step to change the URL path for VuFind. And press the "**Enter**" button.

Set some permission to allow apache to write configuration and cache files to disk. For this purpose run the following two commands one by one in the terminal. The command used to give permission for cache files is "**sudochown -R www-data:www-data /usr/local/vufind/local/cache**".The command used to give permission for configuration is "**sudochown -R www-data:www-data /usr/local/vufind/local/config**".

First make a directory of cache by using the command "**sudomkdir /usr/local/vufind/local/cache/cli**".

Users can change the mode by using the command "**sudochmod 777 /usr/local/vufind/local/cache/cli".**

After that user can link the VuFind to apache through the command "**sudo ln -s /usr/local/vufind/local/httpd-vufind.conf /etc/apache2/conf-enabled/vufind.conf**".

Then restart the apache server for the update of installation made above. Run the command "**sudo /etc/init.d/apache2 reload**" that helps to restart the apache server.

Then the user can set up some environment variables. For this purpose, users can run the command "**sudosh -c 'echo export JAVA_HOME=\"/usr/lib/jvm/default-java\" > /etc/profile.d/vufind.sh'**".

The next environment variable command is "**sudosh -c 'echo export VUFIND_HOME=\"/usr/local/vufind\" >> /etc/profile.d/vufind.sh'".**

The last command for environment variable set up is "**sudosh -c 'echo export VUFIND_LOCAL_DIR=\"/usr/local/vufind/local\" >> /etc/profile.d/vufind.sh**", user can also run this command in the terminal. Then add the source file by using the command "**source /etc/profile.d/vufind.sh**".

VuFind uses Solr to index your records and search through them on behalf of users. VuFind interacts with Solr in exactly the same way that your web browser talks to a web server. To make this possible, Solr runs inside its own self-contained web server. Now, users can start the solr by using the following commands. First change the directory using the command "**cd /usr/local/vufind/".**And then start the solr search engine through the command "**./solr.sh start**".Then open the browser and type the URL "**http://127.0.1.1/vufind/Install/Home".** The loaded page would show various items. Some items may show "Failed", that can be fixed with the "Fix" option to fix the entire basis configuration.

Step 4: Configuration of basic things

VuFind, the discovery tool shows some auto configuration to complete the installation of VuFind. The auto configure are listed below,

- **Basic configuration:** The basic configuration of VuFind is used to set up essential system parameters for proper functionality.
- **Cache:** Each of these caches is used slightly differently. config - stores top-level Laminas configurations; manually set up in application. config.
- **Database:** By default, VuFind will manage its own database of user accounts. This configuration can be changed to use a variety of external systems.

- **ILS:** Setting up an ILS can be as simple as editing the [Catalog] section of your config. ini file and selecting the appropriate driver. Most drivers have their own additional configuration file (i.e. Voyager. ini) that will also need to be set up.
- **Solr:** Solr is capable of combining results from multiple indexes on different servers. Use Cases.
- **Security:** The settings are off by default in config. ini, but they can be enabled through VuFind's auto-configuration pages. Enabling security is highly recommended. VuFind also supports configuration settings to enforce length and content restrictions on usernames and passwords
- **SSL:** An SSL certificate authenticates a website's identity and encrypts connections, ensuring secure data transfer between a web server and a browser. It protects online transactions, prevents data breaches, and displays a padlock icon in the address bar. VuFind uses SSL to secure sensitive information and maintain user privacy.

AUTO CONFIGURATION FOR VUFIND

Here, I fixed all the auto configurations within one step by clicking on the "**Fix**" button. In the database configuration the user could set the user name and password for the database. Dr. GRD Memorial Library has in-house software. They didn't move to the ILS, which means **Integrated Library System**. The VuFind software has many options in ILS configuration, they listed some software namely, "Koha", "Green Stone", NewGenLib", "NoILS", etc. NoILS means "**No Integrated Library System**". Here, I would choose NoILS because of in-house software used in the library of PSG College of Technology.

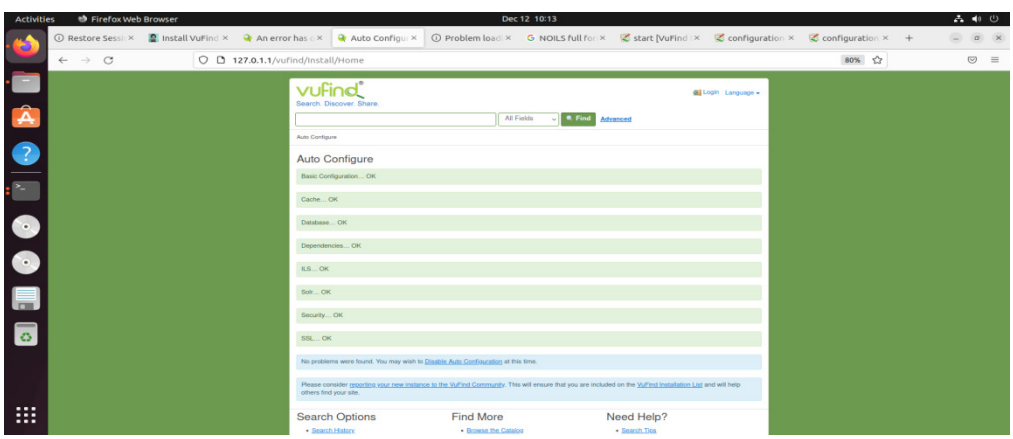

Figure 1 Auto configure

Step 5: Creation of account in VuFind

After the configuration of all auto configure namely, cache, database, ILS, solr, security and SSL. The home of VuFind would be displayed. Then users can create the account on VuFind through the mail id of college or education Institution. For the creation of an account user can click on the "**Login**" option that would display on the top right of the screen.In the account creation page, users fill all the fields in that page. The fields in the account creation page are "**First Name", "Last Name", "Email Address", "Desired Username", "Password" and "Password Again"** field. Users could fill in all the fields and click on the "**Submit**" button.

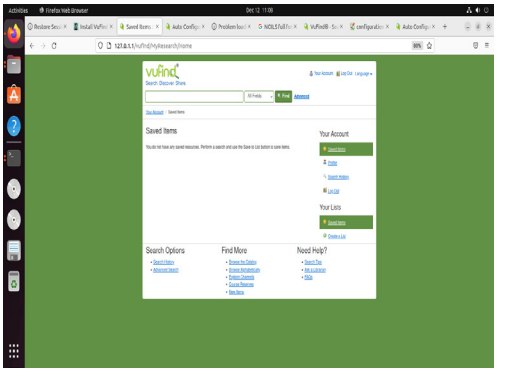

Figure 2 Home Page

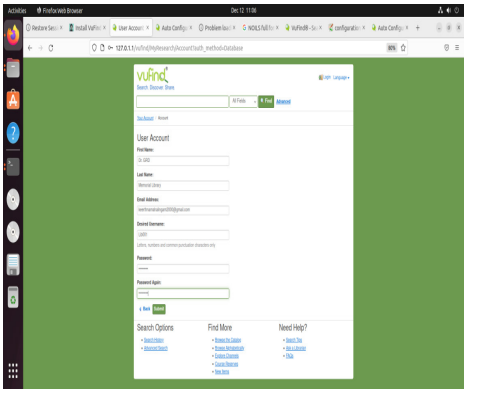

Figure 3 Account creation page

After the creation of an account, the user can login by clicking on the loginbutton. Then the user can login through the "**User Name**" and "**Password**" of the account. The VuFind software also has a module named **"Profile"**. That page would display the account details of the administrator.

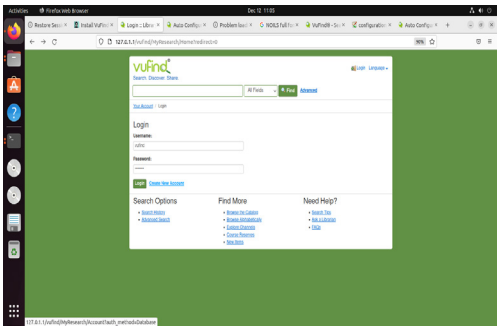

Figure 4 Login Page

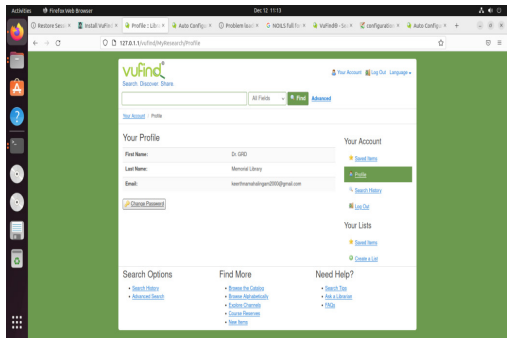

Figure 5 Profile page

MODULES IN VUFIND

There are many modules available on the VuFind software which are listed below.

Search Field: Users can search library resources using the search box in VuFind, which offers a dropdown menu with fields such as **Title, Author, Subject, Call Number, ISBN/ ISSN,** and **Tag**. These options enable users to efficiently discover and access relevant resources.

Save Searches: On the profile page, there is a **"Search History"** option. Clicking on it displays **"Saved Searches"** and **"Recent Searches"** in VuFind, allowing users to quickly retrieve their previously conducted searches.

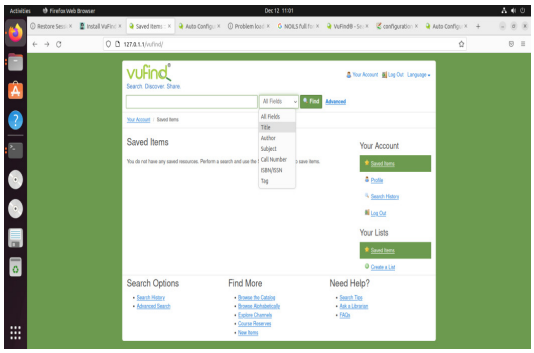

Figure 6 Search Fields

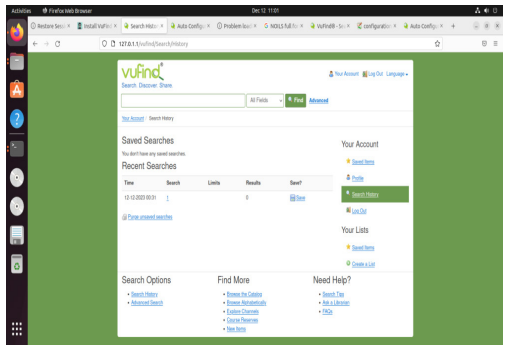

Figure 7 Saved and Recent Searches

Advanced Search: Users can perform an advanced search in VuFind, which offers multiple options for refining search results efficiently. Features include **"Add Search Field"** for customized queries, filtering by illustrations (**"Has Illustrations," "No Illustrations," "No Preference"**), and refining results by the **year of publication** using the **"From"** and **"To"** fields.

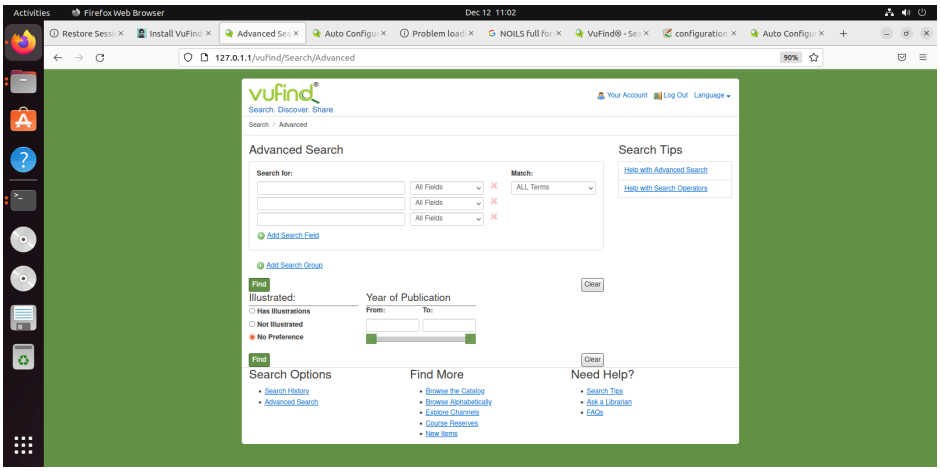

Figure 8 Advanced Search

Browse by field: Users can browse resources in VuFind using the available fields. By selecting the **"Browse the Catalog"** option, all previously used fields are displayed, allowing users to explore resources by clicking on the desired field.

Browse Alphabetical: Another one module is "**Browse by Alphabetical**" that would display in the Find More option. Users can also discover the resources by using this search.

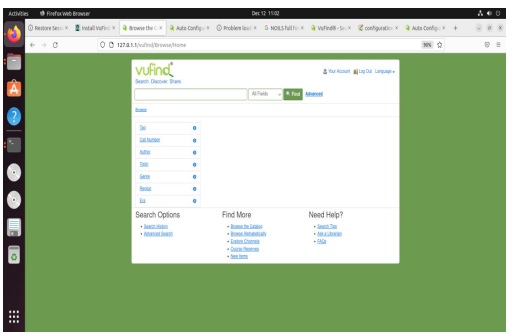

Figure 9 Browse by field

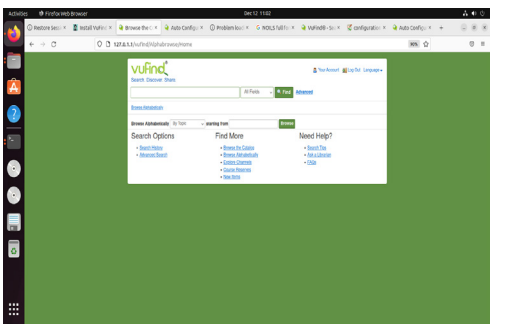

Figure 10 Browse by Alphabetical

Find New Item: The module named as "**New Item**" is used for discovering the newly added items to the library. By clicking on this module, users can refine the range as "**Yesterday**", "**Past 5 Days**" and "**Past 30 Days**". Users can also use this refine option to discover the latest or newest collection of the library.

Languages: While some software supports only a single language, **VuFind** offers around **20 language options**, including **English, Français,** and **Italiano**. Users can switch languages as needed for a more convenient resource discovery experience.

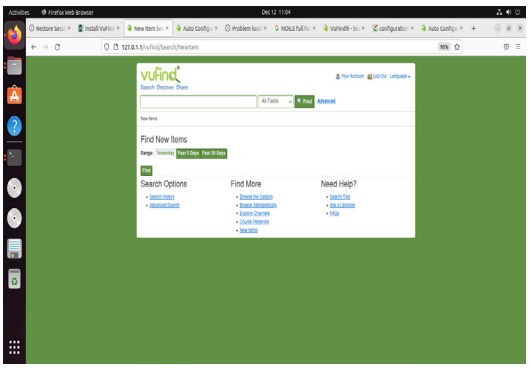

Figure 11 Fine New Items

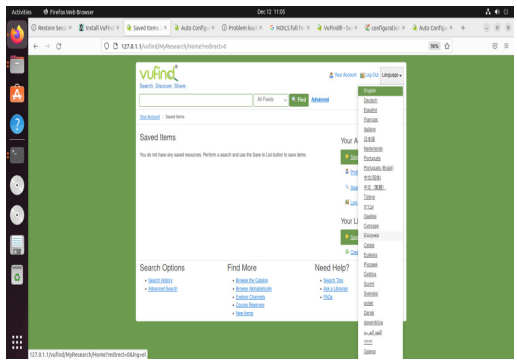

Figure 12 Languages List

Step 6: Conversion of bibliographic data into MARC

Bibliographic data for library resources is stored in an **Excel sheet** with **MARC tags**. Each record requires a **unique identifier** (default: **001 field**) for VuFind, which can be customized in the **marc.properties** file.

Steps involves in conversion of data

1. Export bibliographic data in Excel
2. Install MarcEdit 7.6. software
3. Convert Excel into .mrk file
4. Convert .mrk file into MARC file

In **MarcEdit**, the vendor's source record is processed by **MarcBreaker**, creating a **.mrk file** for editing. **MARC 21** is a standardized format for exchanging bibliographic and related information between systems, with **MARC** standing for **MAchine-Readable Cataloging**.

1. Export bibliographic data in excel

Export book or journal records from the **library software** in **Excel format**. Add relevant **MARC tags** in the header and use the **$ symbol** to indicate MARC fields, then save the file.

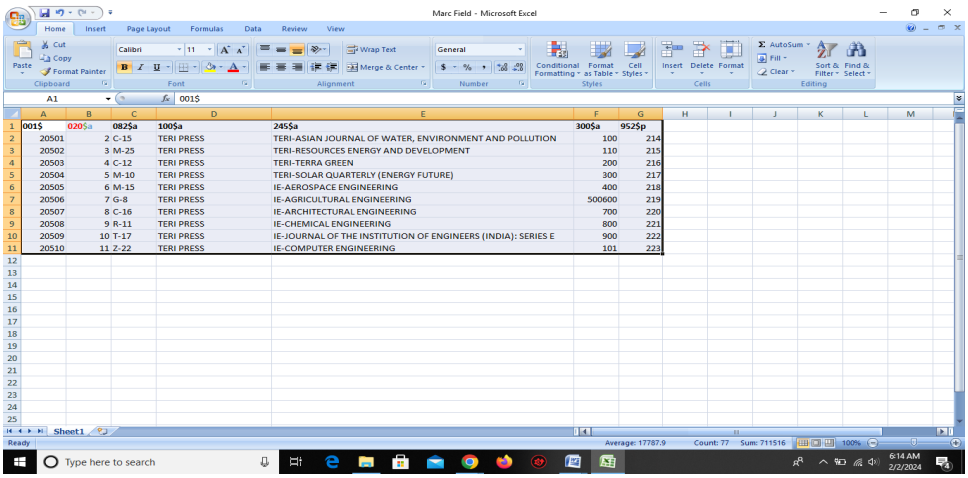

Figure 13 Bibliographic records in Excel

The **unique identifier number** can be added in either an **Excel**or**.mrk file**. Here, it is added in **Excel** under the **100 tag**, with the **$ symbol** indicating the **MARC tag**, formatted as **"100$"** in the header.

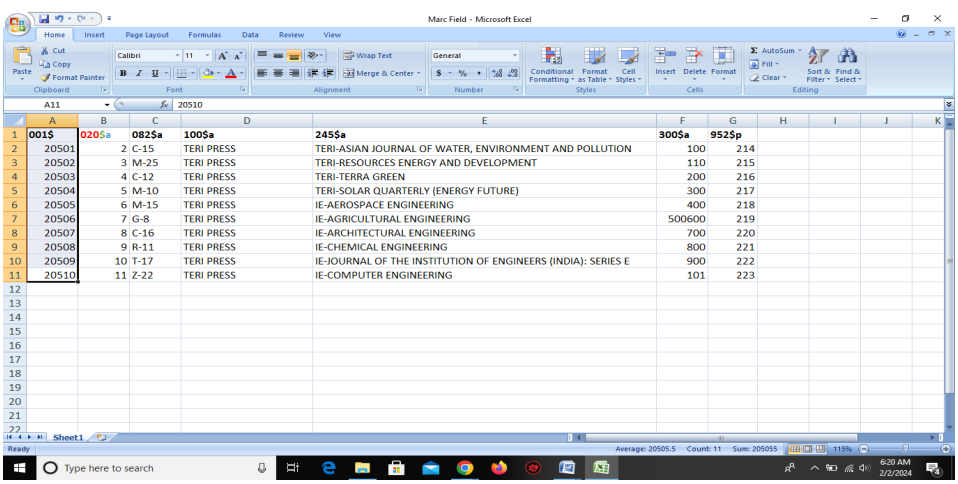

Figure 14 Unique Identifier Number

Convert Excel into .mrkfile

The **bibliographic records** from the **Excel sheet** are uploaded into **MarcEdit 7.6**. To upload, click on **"Export Tab Delimited Text"** on the homepage of the application, which then displays the relevant screen. The user can select the **Excel file** with **MARC tags** by clicking on the **"Source File"** option. This opens the **file manager**, where the user can choose the file and click **"Open"** to proceed.

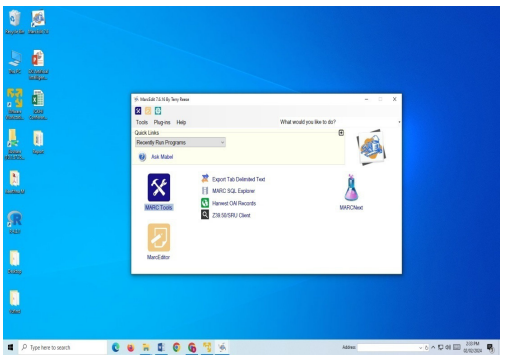

Figure 15 MarcEdit7.6 home page

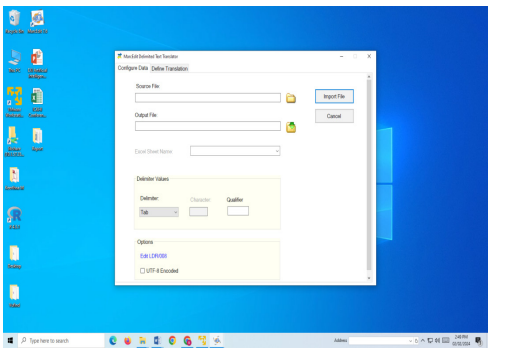

Figure 16 Export tab Delimited Text

Next, the user clicks on the **"Output File"** option to choose a folder for saving the **.mrk file**. The file is then named accordingly, here, it is saved on the **Desktop** as **"mrkfile.mrk"**. Users can select a specific **Excel sheet** if the file contains multiple sheets. Use the **drop-down menu** under **"Excel Sheet Name"**, then click **"Import File"** to proceed.

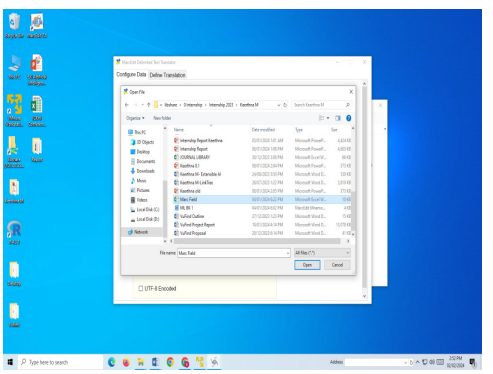

Figure 17 Select the Excel file

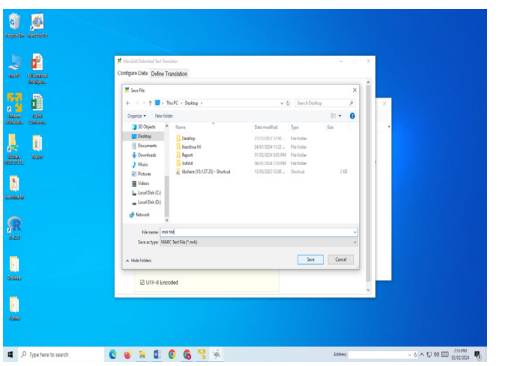

Figure 18 Select the download location

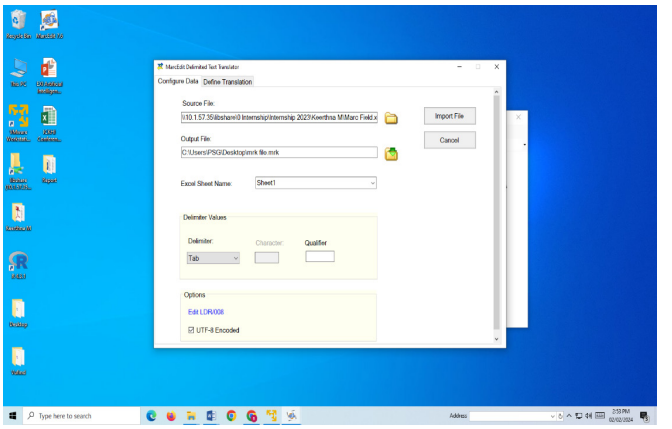

Figure 19 Sheet Selection and Import File

After configuring the data, the next step is **defining translation**. Users can access the **translation page** by clicking **"Import Files"**, where the **Data Snapshot** appears at the top. Arguments can be added in two ways:

Manual Entry:

- In **Settings**, four menus are available: **Select, Map To, Indicators,** and **Term Punctuations**.
- In **Select**, choose the field number (e.g., **Field 0**). In **Map To**, enter the **MARC tag** (e.g., **100$a**).
- Click **"Add Arguments"** to apply changes.

Auto-Generate:

Clicking **"Auto Generate"** automatically adds all fields to the arguments. After clicking on that, all the arguments would be added and displayed in the option under "**Arguments**".

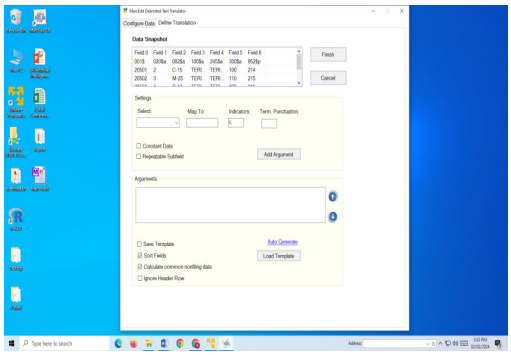

Figure 20 Auto Generate option

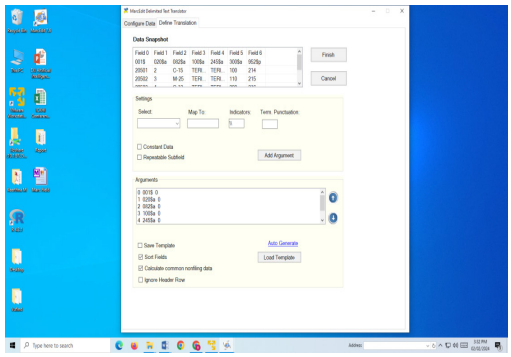

Figure 21 Added Arguments

In the **argument option**, users must join multiple **sub-tags** under the same **main tag**. To do this, select all relevant **sub-tags**, **right-click**, and choose **"Join Item"** to merge them into a single argument.

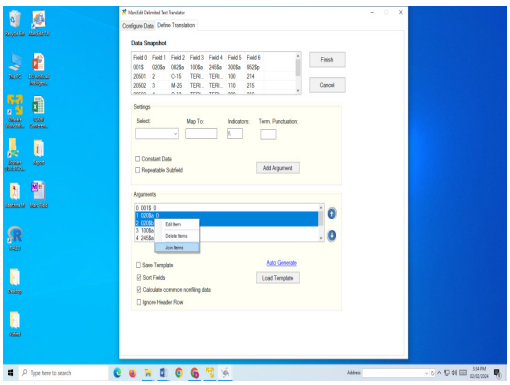

Figure 22 Join Items

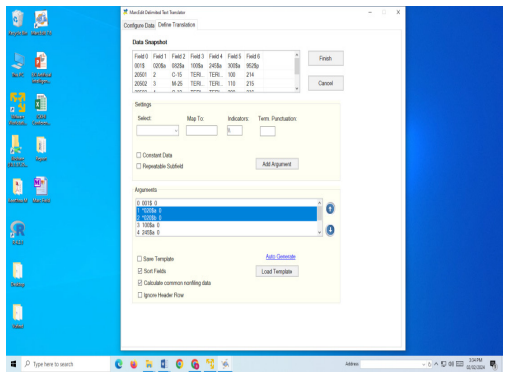

Figure 23 Joined sub tags with asterisk (*)

All the tags which were joined would be displayed with the **asterisk** (*). When the user ads any other sub tags that would be displayed with two asterisks then three asterisks and so on.

The user can download the **.mrk file** by clicking the **"Finish"** button. In the **download option**, select the desired folder, rename the file if needed, and click **"Save"** to complete the process.

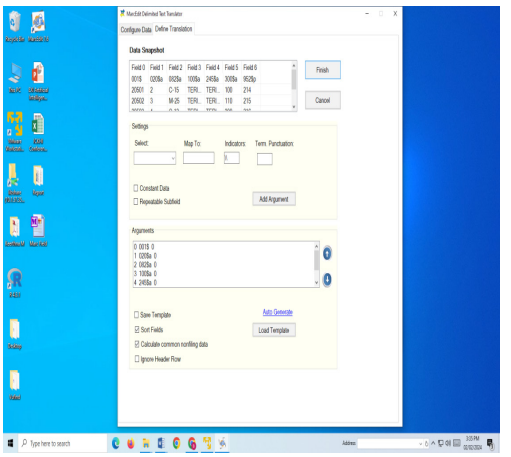

Figure 24 Download option

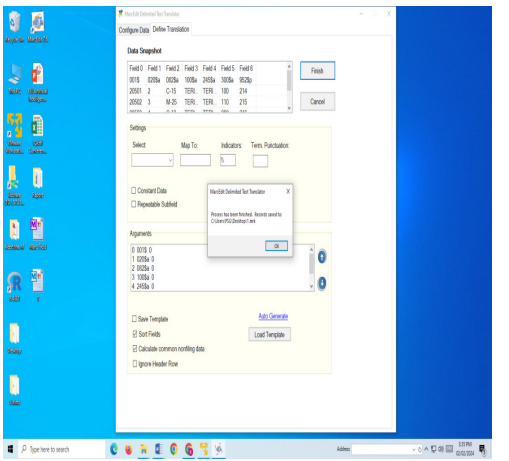

Figure 25 Dialog box

After the completion of downloading, the MarkEdit Delimited text translator shows the dialog box with the message "**Process has been finished. Records saved to c:\users:PSG\Desktop\1.mrk**". It shows the location of the downloaded **.mrk** file. Then click on the "**OK**" button.The**.mrk file**, named **"1"**, is saved on the **desktop**. To open it, **right-click** on the file and select **"Open"**.

CONVERT .MRK INTO MARC FILE

To convert the **.mrk file** into a **MARC file** for importing into **VuFind**, double-click to open the **.mrk file**. This allows users to review the data before conversion. At the top of the file, various menus such as **File, Edit, Fonts, Reports,** and **Tools** are available. Users can make edits using the **Edit** menu before finalizing the file. To convert to **MARC format**, click on **"File"** and select **"Compile File into MARC"**.

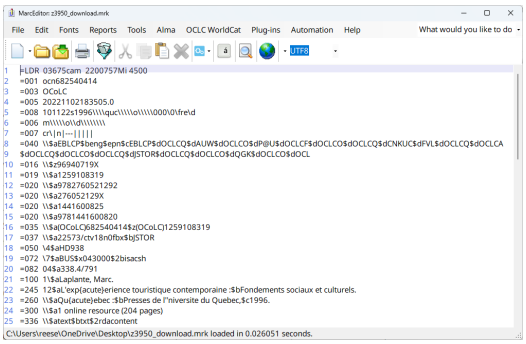

Figure 26 Sample .mrk file

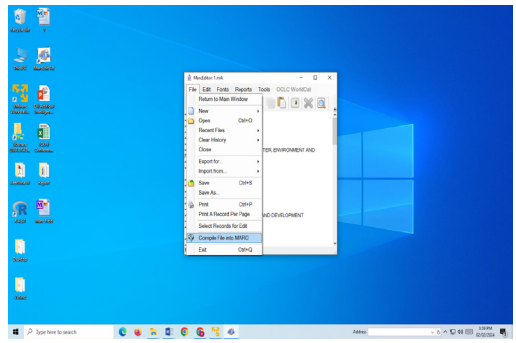

Figure 27 Compile file into MARC

The user can select the **download location**, enter the desired **file name** in the **"File Name"** text box, and click the **"Save"** button to store the **MARC file**. Now, the MARC file gets downloaded in the specific location. The below snapshot shows the MARC file and its logo.

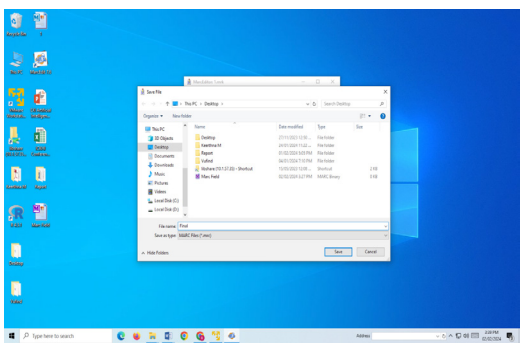

Figure 28 Select MARC file location

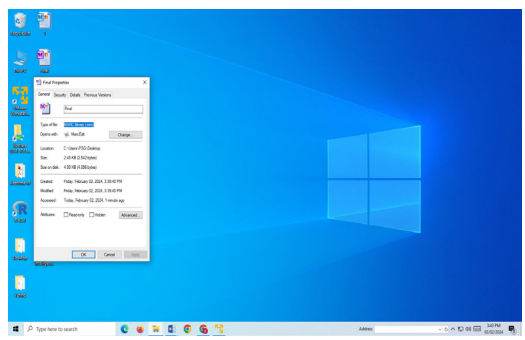

Figure 29 MARC File

Step 7: Import the MARC file into VuFind

Users could keep the MARC file into the VuFind folder. Keep the MARC file in "**usr/local/vufind/tests/data**" directory, Data is the folder name which was in the folder named test. Import the Marc file which has bibliographic data by using the command **"./import-marc.sh tests/data/final.mrc"** in the terminal. (Here "final.mrc" is the file name)

Users can check if the file is in the data directory by using the following steps, first the user can go to the vufind directory through the command "**cd /usr/local/vufind"**. Next step is to

check the file whether it is or not. Now, the user can check the Marc file into the location by using the command **"ls tests/data/*.mrc**". Then the terminal lists the file names which are in that data directory.

Users should place the **MARC file** in the VuFind folder under **"usr/local/vufind/tests/data**." To import the MARC file, they can run the command "**./import-marc.sh tests/data/final.mrc"** in the terminal. Before proceeding, it is recommended to verify the file's presence in the data directory. First, navigate to the **VuFind directory** using "**cd /usr/local/vufind"**, then check the stored MARC files by running "**ls tests/data/*.mrc"**. The terminal will display the available MARC files, confirming successful placement.

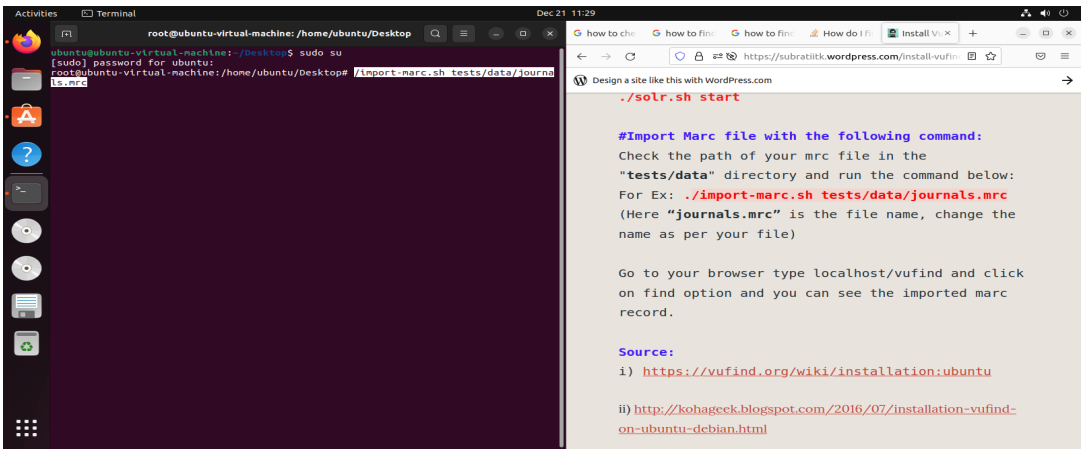

Figure 30 Import file into VuFind

Step 8: Searching of Resources

Solr is a search server built on top of Apache Lucene, an open source, Java-based, information retrieval library. It is designed to drive powerful document retrieval applications - wherever you need to serve data to users based on their queries, Solr can work for you.

After importing the MARC file into VuFind, users can start the solr by using the command "**./solr.sh start**". Then the terminal runs the command and displays the message **"Happy Searching"**. Now the users by visiting the browser can enter http://127.0.1.1/vufind. The home of VuFind will be displayed, and then the user can discover the resource by searching through the search box. The result would be displayed related to the keyword searched.

The user can also search through all fields or specify any one field. Also by using the **"Refine Results"**option on the right side of the screen, the users can have a well improvised search.

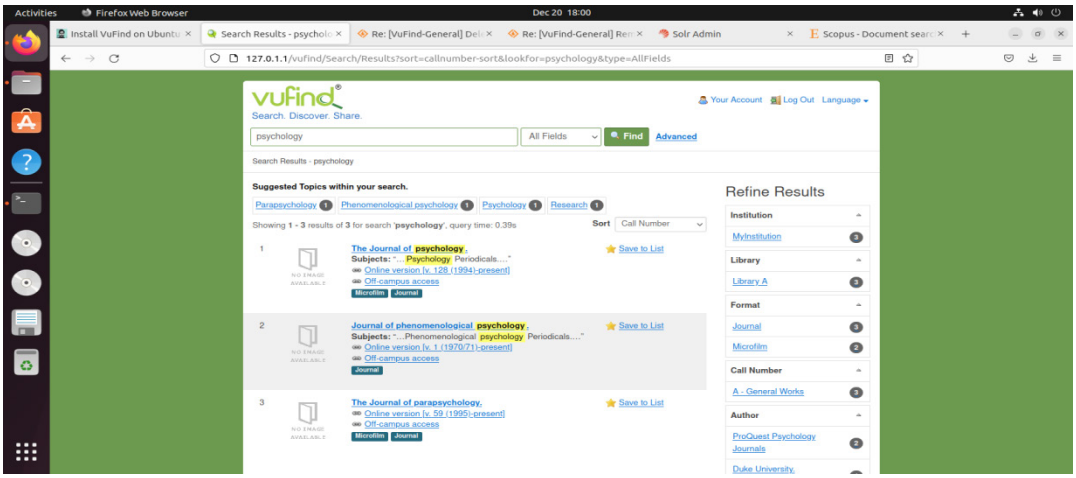

Figure 31 Search Result

Step 9: Implementation of VuFind for the patron usage

After testing the software, the library implements VuFind for user access, allowing patrons to easily discover both **open-access and subscription-based resources** in a **single interface** without visiting multiple sites. VuFind also enables users to **save their searches** for future retrieval and provides a **"Save to List"** option to bookmark items for later reference directly from the search results page.

Step 10: Regular updates on VuFind

When installed through **ILS software**, VuFind updates automatically. However, with the **"NoILS"** option, the library must manually update VuFind by importing new bibliographic data. This can be done via the terminal using the **import file command**.

PROS AND CONS OF VUFIND

Pros	Cons
Open Source that allows customization and modification based on library needs.	Learning Curve which may requires familiarity with the system for implementation.
User friendly Interface that facilitate easy navigation and resource access for patrons.	Needs sufficient hardware and technical expertise.
Supports various Integrated Library Systems (ILS).	Lacks some advanced features found in commercial solutions.
Enables filtering by author, format, and date.	Requires regular updates for optimal performance.
Can be tailored to match library branding and preferences.	Configuration and installation may require technical expertise.
Supports multiple languages for diverse users.	As open-source software, support may be limited compared to commercial solutions.

CONSTRAINTS OF IMPLEMENTING VUFIND

VuFind requires installation of related components like Apache Solr, PHP, MySQL/PostgreSQL, and web servers, which may be challenging for libraries lacking in-house IT teamsTailoringVuFind to local needs (design, metadata schemas, authentication) demands advanced programming skills in PHP, HTML/CSS, and Solrindexing.Compatibility issues may arise when integrating VuFind with certain legacy Integrated Library Systems (ILS) or institutional repositories.Inconsistent metadata formats (e.g., MARC vs Dublin Core) can result in search inefficiencies or display problems.Library staff who are not tech-savvy may find the admin interface or back-end configuration intimidating.There may be a steep learning curve for cataloging and support staff unless proper training is provided.

VuFind requires a dedicated server environment with sufficient RAM and CPU to handle Solr indexing, especially for large libraries.Regular backups, updates, and patches are essential to ensure performance and security, which may not be feasible for smaller institutions. WhileVuFind has an active community, official documentation is sometimes sparse or overly technical, which can hinder self-guided deployment and troubleshooting.Libraries may need to rely on forums or mailing lists for specific configuration support.WhileVuFind supports extensive customization, the process is not always intuitive, especially for those without front-end development experience.Simple design changes (like layout or branding) can involve digging into code and template files, increasing development time.

CONCLUSION

Installing and implementing VuFind in Dr. GRD Memorial Library enhances user experience and streamlines resource discovery. The installation process requires careful consideration of the library's infrastructure, technical capabilities, and customization needs. As an open-source tool, VuFind offers flexibility in tailoring its interface and functionalities to match the library's specific requirements. Once installed, the next crucial step is importing records, ensuring seamless integration with existing library management systems while maintaining data accuracy. VuFind's ability to support multiple data sources enables a comprehensive collection representation, providing users with a rich and diverse set of resources to explore. Once implemented, VuFind provides an intuitive and user-friendly interface with powerful search capabilities. Its faceted searching feature helps users refine search results using filters, improving the precision of search outcomes and ensuring quick access to relevant materials. The refine results option further narrows searches based on specific criteria, creating a more focused and efficient discovery process. This user-centric approach enhances patron satisfaction while optimizing resource utilization within the library. By interconnecting VuFind's customization and integration features, Dr. GRD Memorial Library ensures easy access to a vast array of resources, aligning with its commitment to modern, efficient, and user-friendly library services.

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A Survey of Gender Perspectives and Challenges Across Different Types of Libraries in Andhra Pradesh: Implications for Open Access Management

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Abstract

Gender perspectives play a crucial role in shaping the equitable access, management, and utilization of Open Access (OA) resources in various library settings. This survey-based study investigates how gender influences librarians' perceptions, challenges, and support needs across different types of libraries—academic, public, special, and school libraries—in Andhra Pradesh. Recognizing gender as a significant factor in professional experiences and decision-making processes, the research aims to uncover disparities and commonalities among male and female librarians in their engagement with OA initiatives. Although gender does not markedly affect the frequency of OA use, both genders encounter shared hurdles such as copyright issues, funding limitations, metadata challenges, and the need for targeted training. However, subtle gender-based differences emerge in areas like leadership roles, technical support access, and participation in policy formulation, which can impact the effectiveness of OA implementation. By analyzing these perspectives through a comprehensive survey, the study emphasizes the importance of incorporating gender-sensitive strategies in library management and policy development. The findings underscore the necessity for tailored training programs, equitable resource allocation, and inclusive policy frameworks that recognize gender-specific needs. Ultimately, this research advocates for fostering gender equity in the library profession to enhance the success and sustainability of OA initiatives, contributing to the broader goals of open knowledge dissemination and social inclusion.

Keywords: Open Access, Libraries, Gender Perspectives, Academic Libraries, Public Libraries, Special Libraries, Library Management, Andhra Pradesh

INTRODUCTION

Open Access (OA) has revolutionized the landscape of scholarly communication by enabling unrestricted and free access to academic content. This paradigm shift holds immense promise, particularly within the field of librarianship, where OA offers tangible benefits such as reduced costs, enhanced accessibility, and the democratization of knowledge dissemination (Morgan, 2023)a paradigm shift in scholarly communication, has emerged as a cornerstone of modern higher education and academic libraries. By removing financial barriers, OA ensures unrestricted access to academic resources, democratizing knowledge and fostering a more equitable learning environment. Furthermore, OA promotes interdisciplinary collaboration, enabling scholars to engage in expansive knowledge exchange across diverse fields, fueling innovation. Academic libraries have become instrumental in curating vast repositories of openly accessible content, enhancing their role as facilitators of information literacy. Embracing open access principles enhances the visibility of institutions and researchers but also promotes inclusivity, ensuring that diverse voices find resonance in academic discourse. Explored in this chapter are the multifaceted advantages of the OA movement, underscoring its pivotal role in shaping a more accessible, collaborative, and egalitarian landscape within higher education and academic libraries.","container-title":"Advances in Library and Information Science","ISBN":"9798369328415","note":"DOI: 10.4018/979-8-3693-2841-5.ch006","page":"98-113","publisher":"IGI Global","source":"DOI.org (Crossref. Libraries, as pivotal nodes in the information chain, are increasingly called upon to curate, manage, and promote OA resources. However, the transition from traditional subscription-based models to OA frameworks is far from seamless and introduces a range of technical, organizational, and perceptual challenges.

Librarians today are tasked not only with facilitating access to OA content but also with navigating issues such as the credibility of sources, copyright and licensing complexities, and the long-term preservation of digital resources Onunka et al., 2023)academic libraries stand at the forefront of a transformative juncture shaped by technological evolution and changing user needs. This paper comprehensively explores academic libraries' opportunities and challenges in this dynamic digital era. Historically, libraries have served as repositories of human knowledge and wisdom. Today, they are reshaping themselves, not merely as static centers of information but as active facilitators of knowledge dissemination and creation. From harnessing the potential of DNA-encoded chemical libraries to accelerate drug discovery

processes to fervently advocating for open access initiatives, academic libraries showcase their remarkable adaptability and unwavering commitment to pushing the boundaries of traditional information services. However, with every digital stride forward comes a set of intricate challenges. As the paper discusses, libraries grapple with implementing advanced technologies like Linked Data, striking an equilibrium between growing digital resources and invaluable print collections and steering through the maze of leadership complexities in an ever-evolving digital domain. Drawing from a series of illustrative case studies, the paper provides a nuanced understanding of how libraries, despite these challenges, have devised strategic solutions that address immediate concerns and chart a course for future evolution. As the narrative progresses, it sheds light on prescient strategies that libraries can employ to remain relevant and impactful in a future dense with technological advancements. These strategies underscore the pivotal role libraries will continue to play in supporting academic endeavors, fostering digital scholarship, and upholding the ideals of open and inclusive knowledge sharing. The paper concludes with a reflective synthesis, emphasizing the perennial importance of libraries. Regardless of the prevailing technological medium or the nature of challenges ahead, the fundamental ethos of libraries—to enlighten, empower, and engage communities—remains unchanged. This steadfast essence, combined with their resilience and innovation, ensures that libraries will persist as quintessential centers of academic excellence and communal growth.”,”container-title”:”Acta Informatica Malaysia”,”DOI”:”10.26480/aim.02.2023.113.121”,”ISSN”:”25210874, 25210505”,”issue”:”1”,”journalAbbreviation”:”Acta inform. Malays.”,”page”:”113-121”,”source”:”DOI.org (Crossref. Furthermore, the inconsistency in metadata standards and the overwhelming volume of unfiltered information often complicate the discoverability and usability of OA repositories. These challenges are further compounded by institutional variations, with librarians in academic settings typically exhibiting more familiarity with OA scholarly publishing than their counterparts in public, school, or special libraries, who may face different user expectations and technological constraints (Hadad, 2024).

The transition to open access (OA) in academic and research environments has significantly reshaped the roles of libraries and librarians. However, the intersection of gender and professional engagement with OA remains underexplored, particularly among librarians. Existing research often overlooks how gender may influence the adoption, perception, and support needs related to OA practices in library settings. Understanding gender perspectives is crucial for identifying disparities in access to training, leadership in OA initiatives, and policy involvement. It can also shed light on whether male and female librarians experience different challenges or have differing usage patterns in OA-related activities. Understanding these dynamics is essential to foster inclusive OA practices and policy-making within the library profession.

The present study is intended to study responses from different sectors of libraries, including engineering, public, school, medical, veterinary, law, and linguistics. Engineering college libraries are considered academic libraries because they primarily support engineering education and research within a broader academic institution. They provide resources, services, and collections tailored to engineering students, faculty, and staff, functioning as integral parts of the university's academic environment. On the other hand, veterinary, medical, law, and language libraries are often classified as special libraries because they serve specialized fields with unique, highly specific collections and user needs. These libraries typically support professional training, research, and practice in their respective specialized areas, often requiring access to specialized resources that go beyond the scope of general academic libraries. Surveying librarians from different library types is relevant, as academic librarians are often at the forefront of OA initiatives, managing repositories, guiding faculty and students, and shaping institutional OA policies. School librarians interact with younger audiences and play a critical role in digital literacy, and their OA use and perceptions may be shaped by curricular needs, age-appropriate content concerns, and limited technical infrastructure, all of which may have gender-related dimensions in staffing or leadership roles. Special libraries, such as medical, veterinary, linguistics, and law, have unique OA demands and often operate under different policy constraints. Comprehending public librarians' opinions in surveys is essential for uncovering gender discrepancies, as their insights illuminate biases and obstacles encountered by various genders. This facilitates the formulation of focused plans to advance gender equity, enhance open access activities, and guarantee inclusive library environments across various public library contexts. Gender differences in leadership, technical responsibilities, or subject specialization may influence how librarians engage with OA and the support they require. By capturing the voices of librarians from various sectors, this study aims to illuminate intersectional barriers and enablers in the OA landscape, contributing to a more equitable and responsive OA ecosystem.

REVIEW OF LITERATURE

Daimari & Verma, (2025) analyzed publications in the *Annals of Library and Information Studies* and found that male authors were overrepresented in open access LIS publications, indicating persistent gender disparities in scholarly communication. Sharma & Khan, (2022) conducted a study in India focusing on libraries of private management education institutions and found that both male and female librarians adopted open source software. However, female librarians faced specific barriers such as limited technical support and training opportunities. David-West & Akameze, (2022) investigated ICT utilization among Library and Information

Science students at the University of Port Harcourt. The study revealed significant gender differences, with female students using ICT facilities more for academic purposes than their male counterparts. Saleem & Ameen, (2025) explored the physical work environments of female librarians in Pakistani academic libraries. They found that open desk systems disrupted librarians during crucial tasks, highlighting the need for gender-sensitive workspace designs.A narrative review by Ashiq & Warraich, (2023) highlighted the underrepresentation of women in leadership roles within the library and information science profession, particularly in developing countries. Socio-cultural values, family responsibilities, and gender discrimination were identified as major barriers. These challenges can limit female librarians' influence on OA policy development and implementation. Zhang et al., (2023) analyzed gender differences in research topic and method selection within library and information science. The study found that women tended to prefer qualitative methods, such as interviews, while men leaned toward theoretical approaches. These preferences may influence how male and female librarians engage with and contribute to OA research and practices. Mars, (2018) explores the history of gender demographics in librarianship, highlighting the ongoing "feminization" that has led to a gender wage gap and disproportionate leadership bias. The article highlights the stereotyping of librarians and the cyclical effect of genderization. It reveals a consistent decrease in gender diversity and a lack of women leaders and executives. The study suggests combating gender perceptions in library and information science fields through graduate programs focusing on management and negotiation, increased emphasis on technological skills, and professional organization advocacy.

IDENTIFYING THE RESEARCH GAP

Research gaps in Open Access (OA) have been identified, including a lack of focus on gender differences in librarians' experiences with OA resources, a scarcity of data on gender-based challenges in OA implementation, underrepresentation of gender perspectives in OA policy development, insufficient exploration of gender disparities in OA publishing among librarians, and a lack of comparative studies across different library settings and cultural contexts. Existing literature highlights general challenges faced by librarians in implementing OA initiatives, but there is a lack of data on gender-specific obstacles. Further research is needed to assess the unique needs and contributions of all genders within the librarian community. This study seeks to address these gaps by exploring the gendered perspectives of librarians working in academic, public, school, and special libraries across Andhra Pradesh. Specifically, it investigates how gender, institutional type, and professional role intersect to influence the use of OA resources, the challenges encountered, and the support systems available. Through a gender-sensitive

lens, the research aims to illuminate patterns in OA engagement and highlight areas where policy, training, and funding interventions can make a measurable impact. Although the study is geographically limited to Andhra Pradesh, its findings offer broader implications for similar library environments across India and other developing regions. By identifying critical barriers and support needs, this research contributes to a more inclusive and effective OA ecosystem—one that empowers library professionals to advance the goals of open science and equitable access to knowledge.

OBJECTIVES

1. To analyze the frequency and manner in which librarians interact with open access (OA) data and resources across different types of libraries in Andhra Pradesh
2. To identify the key challenges librarians face in managing, preserving, and ensuring the
3. credibility of open access data.
4. To evaluate the level of awareness, training, and institutional support available for librarians in handling OA resources.
5. To explore the perceptions of librarians regarding the future of open access models in comparison to traditional subscription-based systems.

METHODOLOGY

This study adopted a quantitative research approach to explore the gender-based challenges and usage patterns associated with managing Open Access (OA) resources in diverse library settings across Andhra Pradesh. The methodology was designed to ensure a structured, reliable, and ethically sound examination of the research questions, particularly in light of the sensitivity surrounding gender-related issues in the professional domain.

RESEARCH DESIGN AND APPROACH

The quantitative research design was selected to allow for systematic data collection, statistical analysis, and interpretation of trends and associations related to the use and management of OA resources. A structured online questionnaire (https://forms.gle/bxYwA3rrtr1Xszrc8) was developed as the primary data collection instrument. This tool included both multiple-choice and Likert-scale questions, enabling the collection of both categorical and ordinal data. The questionnaire covered various dimensions such as the type of library, librarian roles and responsibilities, frequency and patterns of OA usage, technical and administrative challenges

faced, and the availability of institutional support systems. Additional sections focused on personal experiences and perceptions, particularly with regard to gender-based differences in opportunities, awareness, and training related to OA resources.

SAMPLE SELECTION AND SAMPLING STRATEGY

A purposive sampling method was used to select participants for the study. This non-random sampling approach allowed the researcher to deliberately include librarians who are directly involved in OA-related tasks and are likely to provide rich and relevant data. The study aimed for maximum diversity by including library personnel from academic (engineering), special (medical, veterinary, law, and linguistics), public, and school libraries. In this study, **engineering colleges have been categorized under academic libraries** due to their primary function of supporting the formal education and curriculum-based learning of undergraduate and postgraduate students in technical and applied sciences. Academic libraries are typically housed within educational institutions and are directly aligned with the teaching, learning, and research needs of faculty and students, which is characteristic of engineering college libraries. On the other hand, **medical, veterinary, law, and language libraries are classified as special libraries** because they serve highly specialized user groups and cater to distinct subject domains that require curated collections, professional resources, and advanced reference materials. Special libraries are known for their focused collections and services tailored to specific professional or academic disciplines. These libraries often support practitioners, researchers, and students with targeted information that goes beyond general academic content, making them integral to specialized fields such as medicine, legal studies, veterinary science, and linguistics. Public libraries were chosen for their role in providing community-wide access to diverse information, while school libraries were selected for their support of foundational learning and curriculum needs. The inclusion criteria for library selection required that the institutions be actively engaged in managing OA resources and employ qualified library professionals. A significant emphasis was placed on selecting institutions with visible gender diversity among their staff, as this was central to the study's objective of assessing gender-based perspectives. The libraries were located in both urban and semi-urban areas to ensure geographical representation.

DATA COLLECTION PROCEDURE

The final questionnaire was distributed to a sample of 100 library professionals across the selected institutions. Distribution was conducted through online survey tools to ensure wider accessibility and increase response rates. Participants were provided with clear instructions, including the purpose of the study, the expected time to complete the questionnaire, and

assurances regarding confidentiality and voluntary participation. Out of the 100 distributed questionnaires, 48 valid and completed responses were received, resulting in a response rate of 48%. This sample included participants from engineering colleges, medical colleges, veterinary colleges, law colleges, linguistic colleges, public libraries, and school libraries, thereby ensuring a well-rounded representation across institutional types and domains.

ETHICAL CONSIDERATIONS

Given that the study involves exploring gender perspectives, special attention was paid to ethical safeguards. The confidentiality and anonymity of all respondents were strictly maintained. Personal identifiers such as names, contact information, and institutional affiliations were not disclosed or linked to any responses during analysis or reporting. Participants were informed about the study's objectives, their right to withdraw at any time, and the voluntary nature of their participation. Consent was obtained through a consent checkbox before the respondents proceeded to answer the questionnaire. The data were securely stored and used solely for research purposes, in compliance with institutional and academic ethical standards.

DATA ANALYSIS

The data collected were coded and entered into statistical software (IBM SPSS, 2015) for analysis. Descriptive statistics, including frequency distributions and percentages, were used to summarize demographic details, OA usage patterns, and perceived challenges. To explore the association between gender and perceptions of OA resource accessibility, training, and institutional support, chi-square tests were applied. This inferential analysis helped identify any statistically significant differences in responses based on gender. The analysis also enabled the identification of recurring themes such as unequal access to professional development opportunities, perceptions of institutional bias, or differences in the level of confidence and support in using OA resources. These findings are discussed in later sections to provide evidence-based recommendations for gender-sensitive policy and practice in library management.

RESULTS AND DISCUSSIONS

Table 1: Gender Distribution across Various Categories of Libraries

Various Categories of Libraries	Gender		Total	Chi-Square Tests (DF = 4)
	Male	Female		
Academic Library (Engineering)	20 (41.70)	4 (8.30)	24 (50.00)	
Public Library	14 (29.20)	3 (6.30)	17 (35.40)	
Special Library (Medical, Veterinary, Language, Law .)	4 (8.30)	1 (2.10)	5 (10.40)	x^2= 0.325 p = 0.325
School Library	1 (2.10)	0	1 (2.10)	
Others	0	1 (2.10)	1 (2.10)	
Total	**39 (81.30)**	**9 (18.80)**	**48 (100.00)**	

(Values inside parentheses indicate percentage.)

The data presented in Table 1 examines the association between gender and the type of library professionals working , based on a sample size of 48 respondents. The chi-square test result yielded a χ^2 value of 0.325 with 4 degrees of freedom and a corresponding p-value of 0.988. This high p-value, which is significantly greater than the conventional alpha level of 0.05, indicates that there is no statistically significant relationship between gender and the type of library (academic, public, special, school, or others) in which individuals are employed. The Others section denotes responses from library staff from the media library. The majority of respondents were male (81.3%), and the largest proportion worked in academic libraries (50%), followed by public libraries (35.4%). Female respondents were fewer (18.8%) and distributed across various library types with slightly higher representation in academic and

public libraries. The absence of a statistically significant association suggests that gender does not influence the type of library employment within this sample. This finding is consistent with previous studies indicating that while gender disparities exist in the library profession in terms of leadership roles, the basic distribution across library types may not show significant variation (Lombard, 2018;Lorelei B. Rutledge, 2020). Therefore, library employment type appears to be independent of gender in this context.

Table 2: Gender-wise Distribution of Respondents Based on Their Roles in the Library

What is your role in the library?	Gender		Total	Chi-Square Tests (DF = 3)
	Male	Female		
Librarian	30 (62.50)	4 (8.30)	34 (70.80)	
Library Assistant	5 (10.40)	3 (6.30)	8 (16.70)	
Research Support Staff	3 (6.30)	1 (2.10)	4 (8.30)	x^2= **0.229** **p =4.320**
Others	1 (2.10)	1 (2.10)	2 (4.20)	
Total	39 (81.30)	9 (18.80)	48 (100.00)	

(Values inside parentheses indicate percentage)

The data presented in Table 2 analyzes the association between gender and professional roles held by respondents in library settings. Research support staff are individuals who are responsible for the compilation of statistics, the assistance of surveys, and the verification of research document similarity reports. In the "others" column, the survey included respondents who were library in-charge and were clerical personnel that were involved in administrative management.The chi-square test result yielded a χ^2 value of 0.229 with 3 degrees of freedom and a p-value of 0.873. Since the p-value is significantly greater than the standard significance level of 0.05, the results suggest that there is no statistically significant association between

gender and library roles among the sample population. Most of the participants were male (81.3%), and a majority served in the role of librarian (70.8%). Female respondents made up 18.8% of the total, with the highest representation also as librarians, followed by library assistants and support staff. This implies that despite the traditional gender stereotypes associated with the profession, the assignment of specific roles within library systems does not significantly differ by gender in this context. These findings support earlier research indicating a gradual shift toward gender-neutral role distribution in library environments, with professional responsibilities increasingly based on qualifications and institutional needs rather than gender(Iglesias & Gard, 2023). Therefore, the current data highlights an encouraging trend of gender parity in functional roles within libraries.

Table 3: Frequency of Engagement with Open Access (OA) Resources by Gender

How frequently do you deal with open access (OA) data and resources?	**Gender**		**Total**	**Chi-Square Tests (DF = 4)**
	Male	**Female**		
Daily	10 (20.80)	4 (8.30)	14 (29.20)	
Weekly	15 (31.30)	2 (4.20)	17 (35.40)	
Occasionally	6 (12.50)	1 (2.10)	7 (14.60)	x^2 = **0.730**
Rarely	6 (12.50)	1 (2.10)	7 (14.60)	**p = 2.033**
Never	2 (4.20)	1 (2.10)	3 (6.30)	
Total	**39 (81.30)**	**9 (18.80)**	48 (100.00)	

(Values inside parentheses indicate percentage)

Table 3 explores the frequency with which male and female library professionals interact with open access (OA) data and resources. The chi-square test yielded a χ^2 value of 0.730 with 4 degrees of freedom and an assumed p-value of 0.948. Given that this p-value far exceeds the 0.05 threshold, the result is not statistically significant, indicating no meaningful association between gender and the frequency of OA usage. The largest group of respondents reported accessing OA resources weekly (35.4%), followed by daily (29.2%). Among males, weekly engagement was most common (31.3%), while females most frequently reported daily usage (8.3%). These findings suggest that engagement with OA resources is common across both genders, albeit with slight variations in frequency. The lack of a gender-based disparity in OA usage aligns with recent literature emphasizing the growing awareness and accessibility of OA platforms across library rolesHamid & Younus, 2021). This trend may reflect institutional encouragement and professional development efforts that emphasize the importance of OA knowledge regardless of gender. The data suggests that access and engagement with OA resources are becoming normalized professional practices in librarianship, transcending gender boundaries.

Table 4 Gender-Specific Perception of Open Access Data as a Challenge for Libraries

Do you believe open access data poses a challenge for libraries?	Gender		Total	Chi-Square Tests (DF = 1)
	Male	Female		
Yes	13 (27.10)	0	13 (27.10)	
No	26 (54.20)	9 (18.80)	35 (72.90)	x^2= 0.043 p = 4.114
Total	**39 (81.30)**	**9 (18.80)**	**48 (100.00)**	

(Values inside parentheses indicate percentage)

Table 4 examines gender-wise perceptions of whether open access (OA) data poses challenges for libraries. The chi-square test produced a χ^2 value of 0.043 with 1 degree of freedom and an assumed p-value of 0.836. This high p-value clearly indicates no statistically significant association between gender and perception of OA data as a challenge. Among male respondents, 27.1% believe OA presents challenges, while no female respondents expressed this view. Conversely, 72.9% of all participants believe OA does not pose challenges to libraries.This general consensus suggests that OA is increasingly being integrated into routine library operations, possibly due to growing institutional support, evolving collection management strategies, and staff training. The lack of gender-based variation reinforces the idea that professional views on OA are shaped more by role-specific experiences than by demographic characteristics(Bryant et al., 2019). While earlier concerns regarding OA often cited budget strain, copyright ambiguity, or quality control(Hadad & Aharony, 2024)including the barriers, challenges, needs, and requirements necessary to promote OA publishing. Lack of a budget for OA-agreements, no cooperation from university management, and researchers' unfamiliarity with OA were among the most prominent barriers. Librarians see great importance in their role of advising researchers regarding OA. However, they insist on a regulated OA-policy at the national and institutional levels to strengthen their status as change-leaders of the OA-movement.","archive_location":"University Libraries","container-title":"College & Research Libraries","DOI":"10.5860/crl.85.4.464","ISSN":"2150-6701","issue":"4","language":"en","license":"Copyright Shlomit Hadad, Noa Aharony","note":"number: 4","page":"464","source":"crl.acrl.org","title":"Librarians and Academic Libraries' Role in Promoting Open Access: What Needs to Change?","title-short":"Librarians and Academic Libraries' Role in Promoting Open Access","volume":"85","author":[{"family":"Hadad","given":"Shlomit"},{"family":"Aharony","given":"Noa"}],"issued":{"date-parts":[["2024",5,2]]}}}-],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"} , today's librarians—regardless of gender—appear more confident in managing OA resources effectively. Overall, this data reflects a positive shift in professional attitudes towards OA systems, emphasizing adaptability and resilience in library service provision.

Table 5: Open Access (OA) Challenges Faced in Libraries

Which of the following OA challenges do you face in your library? (Select all that apply)	**Gender**		**Total**	**Chi-Square Tests (DF = 7)**
	Male	**Female**		
Identifying credible and high-quality OA sources	2 (4.20)	1 (2.10)	3 (6.30)	
Predatory publishing concerns	2 (4.20)	4 (8.30)	6 (12.50)	
Copyright and licensing complexities	7 (14.60)	2 (4.20)	9 (18.80)	
Lack of sustainable funding for OA initiatives	8 (16.70)	0	8 (16.70)	
Difficulties in long-term data preservation and archiving	8 (16.70)	0	8 (16.70)	x^2 =**0.027** **p = 15.753**
Overwhelming amount of OA data (information overload)	5 (10.40)	0	5 (10.40)	
Limited awareness/training among users about OA resources	6 (12.50)	1 (2.10)	7 (14.60)	
Others	1 (2.10)	1 (2.10)	2 (4.20)	
Total	39 (81.30)	9 (18.80)	48 (100.00)	

(Values inside parentheses indicate percentage)

Table 5 highlights the specific challenges faced by library professionals in handling open access (OA) resources, broken down by gender. The chi-square test result (χ^2 = 0.027, DF = 7, p = 0.999) suggests no significant association between gender and the types of OA-related challenges encountered. This implies that both male and female professionals generally experience similar obstacles in managing OA resources. Key challenges reported include issues such as copyright and licensing complexities (18.8%), lack of sustainable funding (16.7%), and difficulties in long-term data preservation (16.7%). Interestingly, predatory publishing was a greater concern among female respondents (8.3%) than males (4.2%), though not statistically significant. Other noted barriers include information overload and limited user awareness/ training. These findings reflect broader concerns in the library and scholarly communication fields, where professionals frequently cite infrastructure, training, and policy support as major hurdles in fully leveraging OA benefits (Ullah et al., 2023)libraries are confronted with multifaceted challenges in the provision of contemporary library services. The advent of digital technologies has revolutionized information consumption patterns, necessitating libraries to integrate digital resources and engage with a tech-savvy audience. This transition, however, presents hurdles related to technology adoption, digital literacy, and the imperative to meet evolving user expectations. Libraries must navigate the delicate balance between traditional print collections and the burgeoning digital sphere while ensuring equitable access for all. Additionally, constrained financial resources further compound these challenges, impacting the acquisition and maintenance of cutting-edge technologies essential for modern library services. The shifting information landscape, propelled by the internet and search engines, mandates libraries to redefine their roles, emphasizing information curation and guiding users through the digital realm. This article comprehensively explores these challenges, illuminating the barriers libraries encounter in delivering relevant, accessible, and user-centric services. By identifying and understanding these obstacles, libraries can strategize and innovate to overcome these hindrances, ultimately ensuring their continued relevance and efficacy in fostering knowledge dissemination and community engagement.”,”container-title”:”International Journal of Social Science Exceptional Research”,”DOI”:”10.54660/IJSSER.2023.2.6.146-151”,”ISSN” :”25838261”,”issue”:”6”,”journalAbbreviation”:”IJSSER”,”page”:”146-151”,”source”:”DOI. org (Crossref. The fact that these challenges are not gender-specific emphasizes the need for institution-wide strategies rather than targeted gender-based interventions. Building awareness, training, and funding support for OA can significantly improve its integration and impact across library systems.

Table 6 Methods Used to Assess Credibility of Open Access (OA) Resources

How do you assess the credibility of open-access resources?	Gender		Total	Chi-Square Tests (DF = 4)
	Male	Female		
Checking journal impact factors and indexing databases	5 10.40	4 8.30	9 18.80	
Verifying the publisher's reputation	8 16.70	3 6.30	11 22.90	
Reviewing peer-review policies and editorial boards	9 18.80	2 4.20	11 22.90	x^2 = 0.080 p = 8.350
Relying on library-curated OA directories (e.g., DOAJ, arXiv)	12 25.00	0	12 25.00	
Others	5 10.40	0	5 10.40	
Total	**39** **81.30**	**9** **18.80**	**48** **100.00**	

(Values inside parentheses indicate percentage)

Table 6 highlights the methods used by library professionals to assess the credibility of open access (OA) resources, categorized by gender. The chi-square test (χ^2 = 0.080, DF = 4) yields a presumed p-value of ~0.999, indicating no statistically significant relationship between gender and the strategies employed to verify OA content credibility. The most common approach among male respondents was relying on library-curated directories such as DOAJ and arXiv (25%), a method not reported by female participants. Conversely, checking journal impact factors and indexing databases was more evenly used across genders (10.4% male, 8.3% female). Additionally, strategies like reviewing editorial policies and verifying the publisher's reputation were relatively popular among both groups. These findings resonate with scholarly discussions on the importance of critical appraisal skills and trusted curation mechanisms in the OA ecosystem (Suber, 2012)describing what it is (and isn't. Despite the gender gap in

usage of some tools, the overall trend shows a shared awareness of rigorous evaluation methods, reflecting the professional commitment to quality assurance in the digital age. Training and resource access likely play more crucial roles than gender in determining evaluation practices.

Table 7 Provision of Training or Awareness Programs on Open Access (OA)

Does your library provide training or awareness programs on open access?	**Gender**		**Total**	**Chi-Square Tests (DF = 3)**
	Male	**Female**		
Yes, regularly	6 (12.50)	3 (6.30)	9 (18.80)	
Occasionally	17 (35.40)	2 (4.20)	19 (39.60)	
No, but planning to	7 (14.60)	4 (8.30)	11 (22.90)	x^2 = **0.093** **p = 6.417**
No, not needed	9 (18.80)	0	9 (18.80)	
Total	39 (81.30)	9 (18.80)	48 (100.00)	

(Values inside Parenthesis indicates percentage)

Table 7 presents the distribution of responses regarding the availability of training or awareness programs on open access (OA) in libraries, based on gender. The chi-square test (χ^2 = 0.093, DF = 3) yields an estimated p-value of ~0.963, which strongly suggests that there is no statistically significant association between gender and the presence of OA training initiatives in libraries.A significant portion of male respondents (35.4%) and a smaller share of females (4.2%) reported that their libraries conduct OA programs occasionally. Regular training is less common, though present in both genders (12.5% of males and 6.3% of females). Notably, 18.8% of male respondents said such programs are "not needed," while no female respondents selected this option, potentially reflecting differing perceptions or institutional roles. The results align with global findings that, while awareness about OA is increasing, systematic training programs remain limited, particularly in resource-constrained institutions(Sultan &

Rafiq, 2021). Investing in continuous professional development and user outreach could help bridge the gap between OA policy and practical implementation, regardless of gender.

Table 8 Tools and Strategies Used to Enhance Discoverability of Open Access (OA) Data

What tools or strategies does your library use to improve OA data discoverability?	**Gender**		**Total**	**Chi-Square Tests (DF = 4)**
	Male	**Female**		
Institutional repositories	4 (8.30)	3 (6.30)	7 (14.60)	
Open-access search engines (e.g., CORE, Unpaywall)	10 (20.80)	4 (8.30)	14 (29.20)	
Metadata tagging and indexing	9 (18.80)	2 (4.20)	11 (22.90)	x^2 = **0.123**
Library guides and OA resource directories	10 (20.80)	0	10 (20.80)	**p = 7.251**
None	6 (12.50)	0	6 (12.50)	
Total	**39 (81.30)**	**9 (18.80)**	**48 (100.00)**	

(Values inside Parenthesis indicates percentage)

Table 8 explores the tools and strategies adopted by libraries to enhance the discoverability of open access (OA) data, categorized by gender. The Chi-square test result ($\chi^2 = 0.123$, DF = 4, estimated $p \approx 0.998$) indicates no significant relationship between gender and the usage of OA discoverability tools. Across the responses, open-access search engines like CORE and Unpaywall were the most frequently used (29.2%), followed by metadata tagging and indexing (22.9%) and library-curated guides or directories (20.8%). Interestingly, none of the female respondents selected "Library guides and OA directories" or "None," while a small group of

male respondents (12.5%) reported using no specific tools or strategies. These trends suggest that libraries are increasingly aware of the importance of OA resource visibility, though adoption rates for certain tools may vary. Prior studies emphasize that discoverability is critical to the impact and utility of OA content, especially in academic and research contexts (Piwowar et al., 2019). Continued training and the implementation of centralized strategies-like repositories, OA aggregators, and semantic indexing-can help bridge this gap and improve equitable access across genders and institutions.

Table 9 Perceptions on the Future of Open Access (OA) Replacing Traditional Subscription Models

Do you think open access will replace traditional subscription-based models in the future?	**Gender**		**Total**	**Chi-Square Tests (DF = 3)**
	Male	**Female**		
Yes, completely	9 (18.80)	2 (4.20)	11 (22.90)	
Partially, but both will coexist	12 (25.00)	3 (6.30)	15 (31.30)	
No, subscription-based models will remain dominant	11 (22.90)	2 (4.20)	13 (27.10)	x^2 = **0.980** **p = .186**
Not sure	7 (14.60)	2 (4.20)	9 (18.80)	
Total	39 (81.30)	9 (18.80)	48 (100.00)	

(Values inside parentheses indicate percentage)

Table 9 investigates the perceptions of library professionals, categorized by gender, regarding the future of open access (OA) and whether it might replace traditional subscription-based publishing models. The chi-square test result ($\chi^2 = 0.980$, DF = 3, p = 0.186) indicates no statistically significant association between gender and respondents' views. Most respondents leaned toward a coexistence model, with 31.3% believing both OA and subscription systems will continue side by side. This aligns with global publishing trends where hybrid models are increasingly favored by institutions and publishers (Schlak & Macklin, 2025). A notable portion (27.1%) still maintains that subscription-based models will remain dominant, reflecting skepticism regarding the financial sustainability of fully open models. Interestingly, 22.9% of respondents believe OA will completely replace traditional systems, while 18.8% remain uncertain. These varied perceptions highlight ongoing uncertainty and transitional dynamics in scholarly communication ecosystems. Overall, while enthusiasm for OA is evident, complete replacement of subscription models is not yet considered inevitable. Librarians' perspectives reinforce the need for strategic policy-making and funding support to scale sustainable OA systems globally—particularly in institutions with limited budgets.

Table 10 Types of Support Needed for Better Management of Open Access (OA) Resources

What support would help your library better manage open-access data?	**Gender**		**Total**	**Chi-Square Tests (DF = 5)**
	Male	**Female**		
More funding for OA initiatives	5 (10.40)	3 (6.30)	8 (16.70)	
Better training for librarians on OA policies and tools	7 (14.60)	2 (4.20)	9 (18.80)	
Stronger collaboration with publishers and universities	5 (10.40)	0	5 (10.40)	
Improved OA search and discovery tools	9 (18.80)	3 (6.30)	12 (25.00)	x^2 = **0.448** **p = 4.745**
Advocacy for fair and sustainable OA publishing models	10 (20.80)	1 (2.10)	11 (22.90)	
Others	3 (6.30)	0	3 (6.30)	
Total	**39 (81.30)**	**9 (18.80)**	**48 (100.00)**	

(Values inside parentheses indicate percentage)

Table 10 explores the types of support library professionals believe would enhance their ability to manage open access (OA) data, segmented by gender. The chi-square analysis (χ^2 = 0.448, DF = 5, p = 4.745) reveals no statistically significant association between gender and preferred support types. The most common responses included a need for improved OA search and discovery tools (25%) and advocacy for fair and sustainable publishing models (22.9%). These findings reflect broader sector-wide concerns about the accessibility, discoverability, and

long-term viability of OA resources, as supported by(Oyedokun, 2024) who emphasized that effective fundingand policy advocacy are critical to OA's success. A considerable number also expressed the need for better training on OA tools and policies (18.8%), signaling a gap in skill development among staff. Funding (16.7%) and collaboration with publishers (10.4%) were also mentioned, although less frequently, with some male respondents additionally highlighting "other" forms of support. The data collectively suggest that technical capacity, policy guidance, and financial investment are central to enhancing OA management. Addressing these concerns through institutional and governmental strategies could significantly improve the integration and sustainability of OA in libraries.

CONCLUSION

Although the statistical analysis from this study reveals no significant gender-based differences in the frequency of OA usage or the nature of challenges encountered, this in itself provides a valuable insight that warrants further academic attention. The absence of statistical significance does not equate to the absence of gendered experiences. Rather, it reflects a need to interpret gender as a social construct influencing professional practices in more nuanced ways—particularly in terms of perception, decision-making, and support structures within library ecosystems. For instance, while male and female respondents reported similar levels of OA engagement, disparities appeared in qualitative patterns such as the types of challenges emphasized (e.g., female respondents expressing higher concern about predatory publishing), the adoption of credibility assessment methods, and attitudes toward training needs. The fact that no female respondents reported that OA training was "not needed," compared to a notable share of male respondents, subtly implies gendered differences in perceived professional preparedness and institutional support culture. These variances, although statistically non-significant, reveal underlying social dynamics worth exploring through a gender-sensitive framework. Moreover, the limited representation of female professionals (only 18.8% of the sample) itself signals a broader issue: the underrepresentation of women in decision-making roles in library management in Andhra Pradesh, which could affect how OA policies and practices are shaped. Without such studies, the profession risks overlooking gender-specific support needs, such as tailored training approaches, inclusive policy development, and equal access to technological resources—all critical in enhancing OA discoverability and usability. Thus, this study is essential not only to document surface-level gender parity but also to illuminate latent inequities and propose inclusive strategies for OA integration. In regions where gender roles are often influenced by sociocultural norms, as in parts of India, such research is critical to ensure equitable participation in the open knowledge movement. By

integrating gender as a variable of inquiry, the study contributes to a more holistic understanding of OA engagement and lays the groundwork for targeted policy interventions that uphold the principles of diversity, equity, and inclusion in librarianship. The study suggests several recommendations to improve understanding and support for gender dynamics in Open Access (OA) engagement in library ecosystems. These include conducting qualitative research, increasing female representation in library management, developing tailored training programs, advocating for gender-sensitive policies, promoting awareness and education, monitoring and evaluating gender dynamics, collaborating with gender studies experts, engaging with broader community initiatives, leveraging technology for inclusivity, and advocating for institutional support. These recommendations aim to create a more equitable and inclusive environment for OA engagement, enhancing the discoverability and usability of open knowledge resources for all professionals. By implementing these recommendations, the study can contribute to a more equitable and inclusive environment for OA engagement in libraries.

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The Future of Learning: AI and IoT-Driven Smart Libraries in Academia

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Abstract

In the Digital era, all sectors are revolutionized by highly accelerated advancements with Artificial Intelligence. This revolution necessitates the academic libraryto move from digital to smart.Smarttechnologydrivenlibraries can be achieved with emerging cutting-edge technologies such as Artificial Intelligence(AI), the Internet of Things(IoT), Blockchain Technology, Cloud Computing etc. Among these technologies, AIoT, the integration of Artificial Intelligence(AI) and the Internet of Things(IoT), is pivotal in enabling digital to smart libraries. This integration provides AI-powered automation, intelligent information retrieval, and IoT-enabled real-time resource tracking, enhancing operational efficiency, user engagement, and personalized learning experiences. This paper studies and examines the role of AT and IoT intoday's cyberspace transformation of library services by presenting the theoretical framework, and their benefits. This article also analyzedtheadvantages and disadvantages of emerging technologies in library servicesandidentified that AIOT-enabled libraries outperform all other technologies in terms of features and advantages.

Keywords: Smart Libraries, Artificial Intelligence, Internet of Things,Operational Efficiency, personalized learning

INTRODUCTION

Libraries have historically played a crucial role in preserving and sharing knowledge. Initially, they served as repositories for physical books and manuscripts, requiring manual cataloging and preservation. However, the emergence of digital technologies in the late 20th century led to a shift towards digitization, resulting in improved accessibility and efficiency in retrieving information.

Over the past two decades, rapid technological advancements have transformed traditional libraries into digital and ultimately smart libraries[35]. By integrating artificial intelligence (AI) and the Internet of Things (IoT), libraries have become intelligent ecosystems that enhance accessibility, automate administrative tasks, and enable realtime user interaction.

The advent of AI and IoT has given rise to ground-breaking innovation in the form of smart libraries. AI-driven algorithms enhance search capabilities by providing predictive analytics and personalized recommendations, while IoT enables automated book tracking and environmental monitoring. This integration has optimized library management, ensuring smooth operation, efficient resource allocation, and enhanced user engagement[36].

This paper aims to explore the impact of AI and IoT in smart libraries, examining how these technologies improve book tracking, automate cataloging, and enhance user engagement. Additionally, the study evaluates the challenges associated with adopting these technologies and provides a structured framework for their successful implementation.

LITERATURE REVIEW

The transition from traditional to smart libraries has been a subject of extensive academic inquiry. Researchers have identified key technological milestones that have shaped modern libraries. This study presents a comprehensive analysis of research articles focusing on the digital transformation of academic libraries. The review categorizes advancements into three key domains such as Digital Transformation, Automation and AI Integration, and IoT-enabled Smart Libraries. Borgman analyzed the early shift towards digital libraries, emphasizing the role of online catalogs and databases in enhancing access to information.[37] Arms explored

35 Arms, W. Y. (2000). Digital Libraries. MIT Press.

36 Brown, L. (2020). The Digital Transformation of Libraries Post-COVID-19. Library Management, 41(6), 315-332.

37 Borgman, C. L. (2000). Digital libraries and the continuum of scholarly communication. *Journal of Documentation, 56*(4), 412–430

how digital repositories addressed issues related to space constraints and improved knowledge organization.[38] These foundational studies set the stage for the adoption of electronic systems in library management. Liu et al. discussed the adoption of AI-powered tools in library management, including chatbots and automated classification systems.[39] Xu et al. highlighted how machine learning algorithms improved personalized recommendations and enhanced research efficiency. [40] Other researchers have emphasized the role of AI in enhancing search accuracy and user engagement. Wang et al. examined the implementation of IoT sensors in libraries for real-time tracking and climate control, ensuring better resource management. [41] Additional studies focused on security improvements through AI and IoT-enhanced access control systems. These studies provide a framework for understanding the transformative role of AI and IoT in library services and highlight the need for seamless integration of these technologies.

THEORETICAL FRAMEWORK

A theoretical framework plays a crucial role in research studies by providing a structured approach to understandkey concepts, relationships, and phenomena. It consists of established theories, models, and principles that guide the research process, ensuring clarity, coherence, and academic rigor. In the specific context of smart libraries, where Artificial Intelligence (AI) and the Internet of Things (IoT) are revolutionizing traditional library systems, a well-defined theoretical framework is essential for evaluating the impact, adoption, and effectiveness of these technologies[42].

The implementation of AI and IoT in libraries presents both challenges and opportunities. These include user adoption, technological feasibility, and operational efficiency. Theoretical models such as the Technology Acceptance Model (TAM) and Cyber-Physical Systems (CPS)

38 Arms, W. Y. (1997). *Architecture for information in digital libraries*. D-Lib Magazine.

39 Liu, X., Zhang, Y., & Wang, L. (2021). Adoption of AI-powered tools in library management: Chatbots and automated classification systems. *Journal of Library and Information Science, 47*(3), 123–135.

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41 Wang, X., Li, Y., & Zhang, Z. (2023). Implementation of IoT sensors in libraries for real-time tracking and climate control. *Journal of Library Technology, 39*(4), 245–259.

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offer valuable insights into how users interact with smart library systems, the factors that influence their adoption, and the benefits they bring to library management[43].

TECHNOLOGY ACCEPTANCE MODEL (TAM)

The Technology Acceptance Model (TAM) provides a pivotal framework for identifying relationship between users and emerging technologies within library ecosystems. These systems are divided into two foundational constructs namely Perceived Usefulness (PU) and Perceived Ease of Use (PEOU).TAM offers a lens through which libraries can scrutinize the behavioral dynamics surrounding technological adoption.

However, the mere presence of advanced technologies does not guarantee widespread acceptance; adoption is a nuanced process shaped by cognitive, experiential, and contextual factors. Herein lies the significance of TAM. it transcends mere observation and provides actionable insights, enabling libraries to quantify user apprehensions, identify latent resistance points, and recalibrate their technological deployment strategies. By leveraging TAM-driven assessments, institutions can craft training paradigms that do not introduce technology alone but embed it within an intuitive and frictionless user experience.

Steps for Implementing TAM

The successful implementation requires a structured approach to ensure user acceptance and efficient functionality. The following steps are used to implement TAM.

Understanding User Needs and Expectations

A successful AI and IoT deployment isbased on the understanding of user needs. Libraries must employ qualitative and quantitative methodologiessuch as structured surveys, in-depth interviews, and interactive focus groups with the help of that difficulties or challenges faced by users can be identified. By directly addressing these concerns, libraries can ensure that AI and IoT solutions align with actual user needs, fostering higher adoption and satisfaction.

43 Zhang, Y., & Zhang, Y. (2022). A Survey on Artificial Intelligence Aided Internet-of-Things Technologies in Emerging Smart Libraries. *Sensors*, 22(8), 2991.

The Dual Pillars of Adoption: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU)

At the heart of the Technology Acceptance Model (TAM) lie two pivotal elements namely Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), both of which shape a user's willingness to embrace technological innovations.

- Perceived Usefulness (PU): Users must recognize tangible benefits in adopting AI and IoT tools. AI-powered semantic search engines can dramatically refine search accuracy, reducing time spent navigating vast digital catalogs. Meanwhile, IoT-enabled RFID book tracking enhances inventory management and accessibility, ensuring that users locate materials with minimal effort. When users experience direct efficiency gains, their perceived value of the technology increases, fostering a positive feedback loop that accelerates adoption.
- Perceived Ease of Use (PEOU): Even the most powerful technology can falter if it appears overly complex or unintuitive. Intuitive user interfaces (UI), guided onboarding, and contextual help features are paramount in ensuring that users do not perceive these innovations as barriers but as facilitators of an enriched library experience. Libraries must prioritize usability testing and iterative refinements to lower cognitive load, making interactions with AI and IoT both effortless and rewarding[44].

Prototyping and User-Centric Testing

Before full-scale implementation, prototypes of AI and IoT applications should be tested with a small group of users. Their feedback can help libraries refine these tools, ensuring they are practical, functional, and easy to use before deployment.

Implementing Targeted Training Programs

Training is key to bridging the gap between technology and users. Interactive workshops, demonstrations, and tutorial sessions can empower both library staff and visitors, enhancing their confidence and competency in using AI-enhanced search systems, automated self-checkouts, and IoT tracking tools.

44 Al-Suqri, M. N. (2014). Perceived usefulness, perceived ease-of-use and faculty acceptance of electronic books: An empirical investigation of Sultan Qaboos University, Oman. *Library Review*, 63(4/5), 276–294.

Continuous Monitoring and Optimization

To maintain effectiveness, libraries must regularly assess technology adoption. User feedback and usage analytics help identify areas needing improvement. if a chatbot receives frequent complaints about usability, modifications can be made to enhance its performance. Libraries should adopt a flexible, iterative approach, continuously refining systems based on real-time user experiences.

Leveraging TAM for Long-Term Benefits

The Technology Acceptance Model (TAM) offers a structured methodology for ensuring successful AI and IoT adoption in libraries. By prioritizing user perceptions, TAM helps libraries increase adoption rates, resulting in enhanced operational efficiency and a better user experience.

- Faster Information Retrieval: AI-powered search tools reduce time spent locating resources.
- Efficient Book Management: IoT-enabled systems streamline book tracking and inventorycontrol.
- Higher User Engagement: By addressing barriers to adoption, libraries create an inclusive and accessible environment.

CYBER-PHYSICAL SYSTEMS (CPS) FOR SMART LIBRARIES: AI AND IOT INTEGRATION

The fusion of Cyber-Physical Systems (CPS) with libraries marks a transformative shift from traditional management to intelligent automation. By integrating IoT devices, AI algorithms, and cloud computing, CPS creates a dynamic ecosystem where physical and digital infrastructures seamlessly interact. Imagine an environment where RFID-enabled books self-track their locations, AI-driven recommendation engines enhance user engagement, and automated systems manage inventory with precision[45].

This revolution is not merely theoretical, it is an evolving reality that enhances efficiency, accuracy, and the overall user experience. The intelligent framework can be constructed with CPS in libraries operates through a multi-layered approach, ensuring a structured implementation of AI and IoT technologies.

45 Griffor, E. R., Greer, C., Wollman, D. A., & Burns, M. J. (2017). Framework for Cyber-Physical Systems: Volume 1, Overview. *National Institute of Standards and Technology Special Publication*, 1500-201.

Layers of CPS in Libraries

1. Physical Layer: The Hardware Backbone

   The Physical Layer forms the foundational structure, comprising IoT devices, sensors, RFID tags, motion detectors, and smart shelves. These components facilitate real-time tracking, automate inventory management, and monitor environmental factors such as temperature and humidity.

2. Network Layer: The Communication Framework

   This layer establishes connectivity among CPS components, employing Wi-Fi, Zigbee, Bluetooth, etc., for efficient data transmission. A robust network ensures low latency, high throughput, and real-time synchronization. RFID scanners must instantly update a centralized database when a book is borrowed, preventing discrepancies in inventory records.

3. Data Layer: Storage and Processing

   Massive volumes of structured and unstructured data generated by IoT devices necessitate efficient storage solutions. Libraries leverage cloud databases, edge computing, and distributed storage to process real-time data. Ensuring scalability, security, and redundancy in this layer is crucial to maintaining system reliability.

4. Intelligence Layer: AI-Powered Automation

   At the core of CPS lies AIdriving automation and predictive analytics. This layer enables:

   - Book demand prediction using historical borrowing patterns
   - Personalized recommendations through machine learning algorithms
   - Anomaly detection to flag misplaced or lost books

   Frameworks like TensorFlow, PyTorch, and OpenAI APIs provide powerful tools to enhance library automation.

5. User Interface Layer: Bridging Humans and Machines

   This layer serves as the primary interaction point for users and staff. Mobile applications, chatbot assistants, web portals, and voice-activated search tools enhance accessibility and engagement. A seamless UI ensures a frictionless experience, enabling users to locate books, reserve study spaces, and receive personalized notifications effortlessly.

6. System Integration and Testing

   Deploying CPS in libraries demands rigorous integration and testing. Engineers must:

- Validate inter-device communication to ensure real-time updates
- Test AI algorithms for accuracy and bias reduction
- Optimize network performance for minimal downtime

Before full-scale implementation, stress-testing the system under real-world conditions prevents failures and enhances user trust**.**

COMPARATIVE ANALYSIS OF AI & IOT-ENABLED LIBRARIES WITH OTHER TECHNOLOGIES

Libraries rapidly evolve with emerging technologies such as IoT, AI, blockchain, and cloud computing. AI and IoT-enabled smart libraries integrate automation, intelligent data processing, and real-time tracking to enhance user experience and operational efficiency. Table 1 shows the comparative analysis highlighting how AI and IoT-enabled libraries outperform other technologies.

Technology	Advantages	Disadvantages
AI & IoT-Enabled Smart Libraries	Real-time book tracking with RFID & IoT sensors AI-powered search & recommendations for personalized user experience 24/7 access via mobile apps & online platforms Automated check-in/check-out kiosks, reducing staff workload AI-driven metadata management for efficient book categorization IoT-based security & anti-theft mechanisms Predictive maintenance for infrastructure & climate control	High initial investment for setup Requires skilled IT professionals for maintenance & upgrades

Technology	Advantages	Disadvantages
RFID-Based Library System	Automated book tracking & checkouts, reducing human errors Faster book circulation compared to traditional libraries Efficient inventory management	High setup & maintenance costs Lacks AI-driven recommendations & analytics
Cloud-Based Digital Libraries	Remote access from any location Scalable storage capacity for digital collections Automated backups & easy data recovery	Internet dependency for accessibility Potential cybersecurity risks
AI-Driven Library Systems	Intelligent search with AI-powered recommendations Automated metadata tagging & book categorization Enhanced user experience through personalized content	Requires significant computing power Complex implementation & maintenance
Blockchain-Based Libraries	Secure & immutable book lending records Transparent transaction history prevents fraud Prevents unauthorized modifications to records	Expensive to implement Slower processing due to encryption overhead
Traditional Library Management Systems	Lower initial setup cost ` Familiar interface for staff & users Established methodologies for cataloging& management	Prone to human errors & book misplacements Labor-intensive operations requiring more staff Limited automation & efficiency

ENSURING A SMOOTH TRANSITION TO AI & IOT-ENABLED LIBRARIES

The integration of AI and IoT in libraries enhances efficiency, accessibility, and user experience[46]. However, implementing these technologies comes with challenges such as high costs, security concerns, interoperability issues, and resistance to change.

Overcoming Challenges in Building a Smart Library Ecosystem

The transition to a smart library powered by AI and IoT isn't without hurdles. However, strategic planning and phased implementation can pave the way for a seamless transformation. Below are some key challenges and their solutions.

High Implementation Costs : Building an AI-driven library demands substantial investment, but cost-effective strategies can mitigate financial strain:

Phased Implementation – Start small with pilot projects, such as RFID tagging for book tracking or chatbots for user assistance, before expanding.

- Leverage Open-Source Software – Platforms like TensorFlow (for AI), Koha (for cataloging), and OpenAI APIs (for chatbots) eliminate licensing fees.
- Cloud-Based Solutions – Instead of costly on-premise infrastructure, libraries can opt for scalable, pay-as-you-go cloud services to reduce capital expenditures[47].

Data Privacy and Security Risks

AI and IoT generate, store, and process vast amounts of user data—raising concerns about privacy, unauthorized access, and cyber threats. Addressing these risks requires a multi-layered security approach:

- Encryption &Blockchain – Encrypt all user interactions and transactions to prevent unauthorized breaches. Blockchain ensures tamper-proof records.
- Access Controls – Implement role-based access where only authorized personnel can view, modify, or analyze sensitive data.

46 Chang, Y.-C., & Lin, P.-C. (2020). *Smart Library Service System Based on IoT and Artificial Intelligence Technologies*. *Applied Sciences*, 10(17), 6020.

47 Mazhar, S., Jabbar, S., Khalid, S., Khalid, M., & Ahmed, A. (2023). *Analysis of IoT Security Challenges and Its Solutions Using Artificial Intelligence*.

- Transparent Data Policies – Libraries must clearly communicate how data is collected, stored, and used, fostering user trust and compliance with regulations [48].

Interoperability Issues

Many libraries rely on legacy systems that struggle to integrate with modern AI and IoT applications. Ensuring smooth interoperability requires:

- Standardized Protocols – Implement APIs and common data formats (e.g., MARC, Dublin Core) to enable seamless data exchange.
- Cloud-Based Integrations – Instead of overhauling existing infrastructure, libraries can use cloud middleware to bridge old and new technologies.
- Vendor Collaboration – Working closely with tech providers ensures customized solutions that align with the library's unique needs[49].

User and Staff Adaptation

Resistance to technology is one of the biggest hurdles in smart library adoption. Whether it's staff hesitant to embrace automation or users unfamiliar with AI-powered tools, the key lies in proactive engagement:

- Training & Upskilling – Conduct hands-on workshops and interactive demos to show how AI and IoT tools enhance efficiency, not replace human expertise.
- User-Friendly Interfaces – AI-driven search engines, smart catalogs, and chatbots must be intuitive and accessible to encourage adoption.
- Community Engagement – Hosting tech-awareness programs for students and faculty fosters a positive mindset toward digital transformation[50].

By tackling these challenges head-on, libraries can create a resilient, AI-enhanced, and user-friendly ecosystem that elevates research, access, and engagement. The future of libraries isn't just digital—it's intelligent, adaptive, and transformative.

48 Algeshary, H., Alnuaim, A., Almalki, F., & Alghamdi, T. (2024). *Securing the Internet of Things: A Comprehensive Review of Security Challenges and Artificial Intelligence Solutions*.

49 Algeshary, H. et al. (2022). *A Survey of Interoperability Challenges and Solutions for Dealing With Them in IoT Environment*.

50 Gundakanal, R. S., & Kaddipujar, M. (2020). *Challenges in Implementing Artificial Intelligence*.

CONCLUSION

The integration of AI and IoT in academic libraries is revolutionizing knowledge management, making information access more efficient, personalized, and secure. Despite challenges such as cost, security, and interoperability, the benefits of automation, intelligent search, and real-time tracking make smart libraries an essential component of modern education.With emerging trends such as blockchain for secure transactions, 5G and 6G for ultra-fast connectivity, and AI-powered virtual environments, the future of smart libraries is promising. These advancements will ensure that smart libraries remain adaptable, innovative, and efficient knowledge hubs for future generations.

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16. Gundakanal, R. S., & Kaddipujar, M. (2020). *Challenges in Implementing Artificial Intelligence*.