# Transforming Academic Libraries: Exploring Emerging Trends and Technologies

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#### Abstract

**Purpose:** This paper aims to provide baseline information about emerging trends and technologies with implications, especially for academic libraries of today and tomorrow.

**Design/methodology/approach:** This descriptive study adopts a comprehensive approach to examine the impact of emerging technologies based on the authors' knowledge and extensive review and analysis of existing literature and scholarly articles related to the discussed technologies.

**Findings:** Technological advancements in this domain complement traditional academic libraries, and it is evident that the adoption of new technology is more prevalent in academic libraries in Western countries compared to India.

**Research Limitations:** This study discusses selected emerging trends and technologies affecting academic libraries based on examples from developed countries.

**Practical Implications:** By implementing the technical development trends discussed in this article, LIS professionals who work in academic libraries would be better able to meet the information needs of their customers.

**Originality/value:** Emerging Trends and Technologies: Big Data, the Internet of Things (IoT), Block Chain Technology, Augmented Reality (AR), Robotics, Artificial Intelligence (AI), Expert Systems, Semantic Web, etc., are still considered new and spendthrift for academic libraries, especially in India. This study will shed some light on this area to make it more understandable. There is also some evidence discussing the transition from a traditional library to a modern library.

*Keywords:* Emerging Trends and Technologies, Digital Technologies for Libraries, Current Trends in Libraries, Block Chain, Big Data, Artificial Intelligence *Article Type:* Descriptive.

**1. Introduction:** Information and Communication Technology (ICT) has become pervasive in our lives, particularly in academic environments. To take advantage of the benefits of ICT, most educational institutions and their libraries have included ICT services in their departments. The latest developments in ICT have opened up new opportunities for delivering information services and managing academic libraries. As Andaleeb and Simmonds (1998) noted, the academic library serves as the heart of the learning community, providing a space for students and faculty to conduct their research and expand their knowledge. With the integration of ICT, Abdoulaye and Majid (2000) confirmed that "new ICT services in academic libraries have brought about a revolution in information generation and usage". The availability of ICT services has expanded access to information globally, without geographical barriers, and in real-time. As technology evolves, academic libraries constantly adapt to meet the evolving needs of students, faculty, and researchers. This article explores the latest trends in technology that are transforming academic libraries, such as big

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data, artificial intelligence, virtual and augmented reality, mobile technologies, and IoT. We will examine the benefits and challenges of implementing these new technologies and how they can transform academic libraries into dynamic learning and research hubs. While implementing new technologies can be costly for academic libraries, it is crucial to do so in order to meet the users' requirements and remain relevant in the ever-changing academic landscape.

**2. Need of the Study:** Academic libraries, despite the high implementation costs, must aspire to adopt new technologies to meet the needs of their users. A feasibility study should be conducted before implementing any new technology, and a focused approach should be taken to ensure its functionality in the future. Technology decisions should consider future growth and change, not just current benefits for users. As academic libraries serve as vital resources for students, faculty, and researchers, understanding how new technologies in academic libraries is crucial for staying up-to-date with the latest advancements in the field. In a rapidly evolving technological landscape, libraries must adapt and evolve to meet changing needs and expectations. By understanding new technologies, libraries can facilitate new modes of research and collaboration, leading to advancements in various fields. Additionally, staying informed about emerging technologies can help academic libraries remain competitive in attracting and retaining users.

3. What is Emerging Technologies: Emerging technologies refer to new and innovative technologies currently being developed or expected to be developed soon. These technologies are typically characterised by their potential to significantly impact various industries and aspects of daily life. According to businessdictionary.com, "emerging technologies are innovations that have the potential to change the status quo. They are new technologies that are presently being created or will be developed in the next five to ten years and will have a significant impact on the economic and social environment." Successful emerging technologies can improve, integrate, and reorganise existing products or generate new advanced products. Emerging technologies are emerging from various fields, including artificial intelligence (AI), biotechnologies, computer technologies, digital technologies, genetics, information technology, medicine, nanotechnology, networking technologies, telecommunications, web technologies, and more. While they have significant implications and potential, emerging technologies have many technological uncertainties and high financial risks. Some examples of emerging technologies include artificial intelligence, virtual and augmented reality, blockchain, the Internet of Things (IoT), quantum computing, and 5G wireless networks. These technologies are often in the early stages of development. They may still need to be widely adopted, but they promise to transform various industries and enhance our quality of life.

**4. Emerging Technologies in Academic Libraries:** Academic libraries are constantly evolving to keep pace with emerging trends and technologies. Some of the most significant emerging trends and technologies in academic libraries are as follows:

a) Mobile Technologies: The prevalence of mobile technologies such as smartphones and tablets has grown significantly in recent years, leading to a notable impact on how people access and engage with information. As a result, academic libraries have taken note of the potential for mobile technologies to enhance their services and create new opportunities for user engagement. One of the most significant advantages of mobile technologies for academic libraries is that they provide users with access to resources and services while they are moving. To this end, many academic libraries have developed mobile applications that

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enable users to search library catalogues, reserve books, and access digital resources from their mobile devices. This has made library services more accessible and convenient for individuals lacking the time or resources to visit a physical library.

In addition to enhancing convenience and accessibility, mobile technologies have opened up new avenues for academic libraries to interact with users. One such example is instant messaging, which libraries can utilise to advertise events, share news and updates, and provide reference services to users who cannot physically visit the library. Another important application of mobile technologies in libraries is related to learning and instruction. By delivering instructional materials such as videos or tutorials via mobile devices, libraries can provide users with flexible and convenient access to these resources. Furthermore, mobile technologies can facilitate collaborative learning and group work by enabling users to easily exchange resources and communicate through their mobile devices.

i) WhatsApp: WhatsApp is a popular instant messaging mobile application that academic libraries can use to facilitate communication and user engagement. Academic libraries can use WhatsApp to provide reference services to users. Students and faculty members can send queries to librarians via WhatsApp, and librarians can respond in real-time. Academic libraries can use WhatsApp to send notifications to users about upcoming events, workshops, and library services. This can be an effective way to keep users informed and engaged with the library. It can also help provide circulation services such as renewal reminders, overdue notifications, and reservation alerts. It also facilitates collaborative learning and group study. Librarians can create WhatsApp groups for users working on similar projects, allowing them to share resources, discuss ideas, and collaborate more efficiently.

**ii) QR Code:** Quick Response (QR) code is another gift of ICT. It is a two-dimensional barcode that can be scanned using a smartphone or tablet to access information or content quickly. Users can scan the QR code using applications such as BeeTagg or RedLaser. In academic libraries, QR codes are used in various ways to enhance the user experience and improve access to information. One everyday use of QR codes in academic libraries is to provide quick access to library resources. For example, QR codes can be placed on physical books or library signage, which can be scanned to give users more information about the book or resource. This can include links to the library's web OPAC, digital versions of the copyright-free resources, or additional information about the author or topic. QR codes can also be used to facilitate library orientation and tours. By placing QR codes on various library spaces and resources, users can scan them to learn more about the library's services and digital resources, and find specific collections or subject areas. In addition, QR codes can be used to gather feedback and suggestions for improvements from library users.

**iii) Mobile Apps:** The existence of mobile apps is also necessary for academics to access library services and information resources. There are some practical mobile applications created by publishers and intermediaries for academic libraries to provide electronic resources, such as e-books, e-journals, and databases, from their mobile devices. There are some mobile-based commercial discovery database applications; e-book apps are available, like KNIMBUS, the Pearson e-library application, IPC Reader, etc., which are popular with library users. Mobile applications help to improve the accessibility and convenience of the library's resources. It can provide users with personalised services, such as customised search results and recommendations based on their interests and usage patterns. This helps to improve the overall user experience and increase user engagement with the library. Libraries now enable payment transactions through various mobile-based apps with new cashless

payment systems. Many libraries take money for various transactions, including paying late fees and making copies.

**b)** Social Media: Academic libraries can leverage social media as a powerful tool to enhance user engagement, promote resources and services, and improve overall user experiences. Social media platforms such as Twitter, Facebook, LinkedIn, and Instagram can be used by academic libraries to promote resources and services, including new acquisitions, research guides, and workshops, increasing awareness and usage of the library's collections and services. Moreover, social media can facilitate communication with library users, assisting them and answering their queries. These platforms allow academic libraries to share daily news, event announcements, and updates and market their services and resources. Using social media, academic libraries can connect with new users, engage with those unaware of the library's resources, and collaborate with other libraries and organisations.

Additionally, social media can be used to conduct surveys, polls, and other forms of user feedback to better understand user needs and preferences, leading to continuous improvement of library services and resources (Istiana, 2017). At Gadjah Mada University in Yogyakarta, Indonesia, three faculty libraries made use of Facebook to promote their collections and services, document activities, greet users, and provide important information to users (Al-Daihani, 2016). Twitter is an information source for Kuwaiti undergraduate students.

c) Big Data: Big data analytics can enable academic libraries to enhance their services and resources by gaining insights into user behaviour and preferences. Big data refers to the vast amounts of structured and unstructured data generated across various domains. With big data analytics, academic libraries can track usage statistics of their resources, including e-books, journals, and databases, to identify popular resources, peak usage times, and the types of devices used to access them. Analysing user behaviour, such as search queries, browsing patterns, and resource usage, can inform collection development decisions and help identify gaps in the collection. Big data analytics can also develop personalised recommendation systems based on users' interests and usage patterns, suggesting relevant books and articles. The Harvard University Library developed the analytics toolkit that enables librarians and users to recognise and react to trends and changes in collections, usage, and other data. Overall, big data analytics can optimise academic library resources and services to better meet user needs. Numerous data initiatives are hosted on the campus of the University of California, Berkeley libraries. They comprise the California Policy Lab, the Berkeley Institute for Data Sciences (BIDS), and the social sciences-focused D-Lab.

d) Internet of Things (IoT): The Internet of Things (IoT) is a network of physical devices, buildings, vehicles, and other objects with sensors, software, and connectivity that allow them to collect and exchange data. This interconnectedness enables many applications, including smart homes, cities, industrial automation, and healthcare. The Internet of Things is the most influential technology for library services nowadays. Minor computing, radio devices, the cloud, the user interface, the gateway, analytics, and artificial intelligence will sense and transmit the data (ALA, Internet of Things, 2018). Academic libraries can benefit from IoT technology in various ways. To provide a virtual tour and orientation for newly registered patrons. Patrons can download an app on their mobile devices and access a virtual tour video that introduces the library and helps them become familiar with it. A shelf guide can be created from a patron's favourite list to help them locate their desired resources. By creating a profile and listing their favourite books, CDs, DVDs, theses, etc., a video or audio shelf guide can play from their favourite list whenever they come to the library, making it easier to find items. IoT devices can automate routine tasks such as book check-in and check-out, inventory

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management, and cleaning schedules. By monitoring the usage of library resources, sensors can optimise the allocation of space and resources. Personalised experiences can also be provided to users through IoT technology. For instance, beacons can send alerts and recommendations based on the user's location, interests, and past searches. IoT technology can inform patrons about the fines they owe and allow them to pay online without the need to stand in queues. IoT devices can also facilitate data collection on user behaviour, resource usage, and environmental factors, which can inform collection development decisions and identify areas for improvement in academic library services. Muhammad Asim et al. (2022) found that Pakistani university libraries have integrated IoT-based appliances such as smart air conditioners, automatic fire alarms, intelligent hand sanitizer machines, and innovative security doors.

e) Block Chain Technology: Satoshi Nakamoto proposed the concept of blockchain in 2008 to create a decentralised electronic cash system that operates on a purely peer-to-peer basis. This led to the development of the digital currency known as Bitcoin, which was launched in 2009. Academic libraries can utilise blockchain technology, a decentralised ledger system that allows for secure and transparent transactions without a central authority. One possible application of blockchain technology in academic libraries is managing digital rights and permissions for library resources, such as e-books and articles. By creating tamper-proof records of ownership, licencing, and usage rights, blockchain technology can ensure the long-term preservation and accessibility of digital materials.

Additionally, decentralised and robust storage networks can provide a reliable and transparent audit trail of preservation activities. One such example is a supercomputer created by Stanford University and used for the medical research library, which increased the capacity of an entire network. (Babich and Hilary, 2018) Another potential use of blockchain technology is to enable secure and transparent tracking of inter-library loan activities, reducing transaction costs and streamlining the inter-library loan process. It can also be leveraged to create decentralised platforms for open-access publishing and the sharing of academic research. Blockchain technology can facilitate the creation and sharing of open-access materials by securely tracking authorship, licencing, and usage rights.

**f)** Augmented Reality (AR): Augmented Reality (AR) is an interactive technology that superimposes digital information, such as videos or images, onto the physical world, enhancing the user experience and providing novel ways to engage with academic library resources. The integration of AR in academic libraries offers immersive and interactive experiences for users, for instance, the creation of virtual tours or interactive maps to navigate the library space. The Library of Birmingham in the UK used AR technology to create an interactive exhibit that allows visitors to explore the city's history. The exhibit features a 3D city model that visitors can view using a tablet or smartphone. (BBC News, 2013)

Additionally, AR can amplify the discovery and exploration of library resources by enabling users to scan book covers or QR codes to access supplementary information such as reviews, summaries, and related resources, thereby increasing user engagement and informed decision-making. The University of Maryland Libraries have developed an AR app that allows users to explore the collections and resources of the library in a virtual environment. The app uses location-based technology to guide users to different library areas and provide information about the resources available in each area. The National Library Board of Singapore has developed an AR app called "NLB Mobile" that allows users to access library resources and services using their mobile devices. AR can also create interactive learning experiences for students, such as visualisations or simulations that simplify complex concepts or interactive quizzes or scavenger hunts that make learning fun and engaging. Moreover, academic libraries can leverage AR to create captivating and interactive exhibits by

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augmenting physical exhibits with additional information and interactive features, thereby boosting visitor attraction and engagement with the library's collections.

g) Robotics: Robotics involves designing, constructing, and operating robots with applications in various fields, including academic libraries. In academic libraries, robotics can automate book-handling tasks such as sorting, shelving, retrieval, and delivery, reducing the workload of staff and improving efficiency and accuracy. Robotics can also help manage library inventory, including circulation, shelf stocking, and materials handling, leading to better accuracy, efficiency, and fewer errors. The Frisco Public Library in Texas, USA, has a robotic book sorting system that can sort up to 3,000 books per hour. Digitization of library materials, such as books, journals, and manuscripts, can also be supported by robotics, with automated scanning systems improving accuracy and speed, making library materials more accessible to researchers worldwide. In addition to this, robotics can assist in cleaning and maintaining library facilities, including floors, carpets, and furniture. Automated cleaning systems can reduce cleaning staff workload, improve library cleanliness, and reduce the spread of germs and diseases. Robotics can also provide customer service and assistance to library users, with robots programmed to provide information about library services, help users locate books, or even provide essential research assistance. For instance, students from Rajagiri College's computer department in Kerala developed robots to assist and guide library users. The Chicago Public Library, for example, has partnered with Google Chicago and provided 500 Finch Robots for check-out and in-house use. The University of Texas at Arlington Library is launching a pilot programme to check out telepresence robots to allow distance users to connect with people in the library. Moreover, robotics can analyse library operations and services data, such as circulation statistics, patron usage patterns, and collection development trends, helping librarians make informed decisions on improving library services and operations.

h) Artificial Intelligence (AI): Artificial intelligence (AI) is an area of computer science that aims to reduce the gap between man and machine. Alternatively, in other words, it aims at creating machines that behave or react like humans. It is used across various fields, including medicine, business, education, gaming, and libraries. The use of AI in libraries was first introduced in 1990. Since then, it has been widely used in academic libraries to improve the user experience, operational efficiency, and decision-making processes (Asemi & Asemi, 2018). AI can be applied in various areas of library systems, such as descriptive cataloguing, subject indexing, reference services, technical services, shelf reading, collection development, and information retrieval systems. Corke (2013) reported that researchers and experts in artificial intelligence are creating intelligent systems that can think and behave like librarians - library robots. AI-powered chatbots can provide quick and efficient customer service to library users, answering frequently asked questions, helping users locate resources, and providing essential research assistance. The University of Cambridge Libraries in the UK uses AI to help with book discovery and retrieval. AI can improve search functionality in library databases through natural language processing algorithms, that interpret user queries and retrieve relevant search results. Personalized recommendations to library users based on their search history, borrowing history, and reading habits can also be provided by AI. AIpowered image recognition can digitise and organise library collections, identifying book covers, manuscripts, and other materials to make categorization and retrieval easier. AI can also analyse library data, such as circulation statistics, patron usage patterns, and collection development trends.

i) Expert Systems: Expert systems are software programmes that replicate human decisionmakers' abilities in a particular field. They aim to tackle complex problems in a particular

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area by simulating an expert's decision-making process. Typically, expert systems consist of three main components: a knowledge base, an inference engine, and a user interface. Expert systems have been applied in various fields, including medicine, engineering, finance, and agriculture, to assist with decision-making and problem-solving, including libraries, where they can assist with tasks requiring expert knowledge. In academic libraries, expert systems have multiple applications, such as providing reference services to answer frequently asked questions and offer guidance to users. The AskUschatbot from the University of North Texas Libraries is a conversational expert system that uses natural language processing and machine learning to answer patrons' questions quickly and accurately.

Additionally, they can analyse library usage, circulation, and user behaviour data to provide recommendations for collection development. Expert systems can also help automate the cataloguing and classification of library materials by identifying relevant subject headings and class numbers based on the material's content. They assist users in finding relevant information by analysing their search queries and providing recommendations based on their needs. The University of Illinois at Urbana-Champaign Library's LibraryBot expert system uses machine learning to provide personalised recommendations to patrons based on their search history and reading preferences. Finally, expert systems can also be used to analyse the condition of library materials and recommend appropriate preservation and conservation measures.

i) Semantic Web: A feature of the World Wide Web known as the Semantic Web is the ability to interchange and reuse data between many platforms, applications, and systems. It uses a set of standards and technologies to describe and represent data in a machine-readable format, enabling computers to understand and interpret the meaning of the data. The semantic web has the potential to transform the way academic libraries manage and share data, promote collaboration and interoperability, and enhance the user experience for students, faculty, and researchers. It provides a standardised way of describing and organising metadata, making it easier for academic libraries to manage and share metadata across different systems and platforms. It will enhance the search capabilities of academic library catalogues by providing more accurate and relevant search results based on the meaning and context of user queries. Academic libraries can communicate and exchange data with other libraries and systems via the semantic web, fostering cooperation and interoperability across various institutions. BibFrame is a data model for bibliographic description that allows libraries to manage and share metadata for their collections in a machine-readable format with other libraries and systems. It enables academic libraries to produce and distribute linked data, which links information from many sources and offers a more thorough and connected perspective on scholarly resources. Several libraries, such as Harvard Library, the University of California Libraries, the University of Manchester Library, etc., use linked data to integrate and expose data from different library systems, including library catalogues and digital repositories. By making personalised recommendations based on the user's interests, preferences, and past search history, the semantic web is also utilised to enhance the user experience in academic libraries.

**k)** E-resources: E-resources refer to electronic or digital resources available in digital format. They comprise digital content available online or through other electronic means, such as e-books, e-journals, online databases, audio and video resources, and other digital content. Academic libraries acquire e-resources more frequently to aid research, teaching, and learning. The current trend in academic libraries is the expansion of e-resource collections to meet the changing needs of library users. The availability of open-access online resources is one trend in electronic resources. Open access (OA) is a movement that aims to make scholarly research and literature freely available to everyone. Many academic libraries

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support the open-access movement by providing access to open-access journals and other resources. The e-book is another trend that offers the convenience of accessing books anytime, anywhere. Many academic libraries have expanded their e-book collections to support the growing demand for digital content. Academic libraries are also increasingly offering e-resources that support multimedia and interactive content such as videos, simulations, and other multimedia content that can enhance learning and research.

5. Conclusion: We are living in a period of rapidly expanding technology in hardware, software, and online, and it appears that these rapid changes will continue to grow. This technological change has revolutionised academic libraries, opening new opportunities for delivering information services and managing resources. The latest trends in technology discussed in this article, such as big data, artificial intelligence, virtual and augmented reality, mobile technologies, and IoT, are transforming academic libraries into dynamic learning and research hubs. While implementing these new technologies may be costly, meeting the users' requirements and remaining relevant in the ever-changing academic landscape is crucial. Feasibility studies and a focused approach should be taken to ensure the functionality of new technologies in the future. Studying emerging trends and technologies in academic libraries is essential for staying up-to-date with the latest advancements in the field, enabling new modes of research and collaboration, and helping academic libraries remain competitive in attracting and retaining users. The future of libraries is poised to become intelligent libraries that provide access to information and research, analyse data, and communicate findings with users, much like a colleague would (Noh, 2015). Academic libraries must continue to adapt and evolve to meet the changing needs and expectations of students, faculty, and researchers in the rapidly evolving technological landscape.

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