

Visualizing the Academic Library of the Future Based on Collections, Spaces, Technologies, and Services

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Abstract

This paper analyzed the literature on collection development, space planning, futuristic technologies, and information services related to academic libraries. The content analysis method was applied to review these papers. The selected papers for review have the potential to influence the future of academic libraries. This review of the related studies shows that the academic library has evolved into a hybrid model, combining traditional collections and a modern, sophisticated knowledge warehouse. It is predicted that the future library will be a place for aesthetic, emotion-rich social centers and will act as a knowledge refinery. Developing innovative technologies and services and improving the skills of library staff are significant challenges for the future. This study has designed a new conceptual framework in this area, identifying the possible scenarios for future academic libraries.

Keywords: Library services; Innovative technologies; Future of academic libraries.

Introduction

Since the Nineties, libraries have started the transformation from collection-centric to client-focused. The library became a space for innovation and idea creation using maker spaces (Webster, 2019). As a result, libraries have become a top priority for institutions looking to modernize campus facilities to accommodate new students and study patterns.

The issues that libraries and librarians face revolve around the core premise: Will the growing use of electronic sources and online reading lessen the need to store and access real books? Is there any impact on space due to the physical to digital shift as libraries plan for the future? As we address these questions, one of the most difficult challenges we will face concerns the hybrid space and the library concept. For many, the library has become a substitute for a more extensive set of issues confronting higher education. These are the fundamental concerns of our inquiry as we seek a more comprehensive view of the present and future of academic libraries.

This article reviewed the Association of College & Research Libraries (ACRL) reports on top trends and issues in American academic libraries, published biennially since 2010. The report focuses on research data services, open educational resources, scholarly communication,

Altmetrics, learning analytics, student success, digital scholarship, and information literacy. This article has used the trends and issues reported by the ACRL to design a framework of emerging themes, to investigate the trends in the future of academic libraries.

Academic libraries are at a critical juncture where new technologies, changes in reading habits, and efforts to manage higher education mounting expenses have thrown its facilities and purposes into disarray, casting doubt on the utility of books in the digital era. As colleges and universities cope with the shifting educational landscape, there is an increasing need to know what the library will look like in the future.

1. Changing needs and expectations of library patrons

The changing lifestyle of patrons is one of the critical factors for improvement in academic libraries. Several user surveys have shown that patrons need libraries to fit their lifestyles, not the other way around. As a result, the future academic and research library will be essential for patrons in their daily lives. The library should be modular, adaptable, and agile, with favorite destinations and touchpoints for patrons (Choh, 2011; Council on Library and Information Resources, 2008). Many library futurists have urged the complete digital library to become the norm, with all books being replaced solely by eBooks (Durant & Horava, 2015).

Patrons in the twenty-first century are increasingly expecting to use ICTs for instructional purposes. They have more access to educational materials and services because of these technologies. It is easy to see why students clamored for more open access to information, digital referencing, mobile-based services, and information-sharing options from librarians and libraries, leading to "information anywhere, at any time" (Fatoki, 2006).

The future academic library will deliver library services based on patrons' location and available tools. As a result, the services will be tailored to the devices in their palm. The services will be provided using a model of "one service, several expressions" (Choh, 2011). Patrons will not mind how or where information is stored or organized as long as they can connect to it using their own devices and in their physical places. Academic libraries must focus on the user-centric movement and beyond to initiate progress in this environment.

Literature Review

After analyzing various literature of the last few years, we observed that the library's future depends on four significant themes: collections, spaces, technologies, and services. Google Scholar was used to retrieving literature in these areas. The Content review and descriptive methods were applied to review the literature. The most recent literature was assessed and placed in the respective tables.

In the future, the library will have to choose the collection wisely. The collaborative collection development will provide better access to various relevant resources in the most cost-effective manner. The cost-per-use will be the crucial factor for collection development criteria; tools like COUNTER 5 and UNSUB will be helpful for decision-making. The collection will be considered a service by building appropriate resources most cost-effectively. The library will have to adopt, promote and maximize the utilization of open educational resources. Zero textbook cost (ZTC) will be the outcome of adopting Open Educational Resources (OER), providing affordable course content. Academic librarians must come together to bring uniformity in making an e-resource access policy/license agreement and adopt Shared Electronic Resource Understanding (SERU). The consortium of libraries will help develop a

virtual library like VIVA (Virtual Library of Virginia). Acquiring unstructured datasets and on-demand streaming media will also be a new approach to collection development. The details of recent literature on collection developments are analyzed and listed in Table 1.

A few notable publications in library space design were analyzed and listed in Table 2, and we found that most of the documents emphasized the learning and research commons. However, the studies related to space planning closely relate to innovation and creativity. Components such as interior space, architecture, and design increase the importance of library space. Therefore, the current academic libraries can be improved by integrating creative and maker spaces. In general, the space provided to users in the library leads to a change in the patron's attitude towards the library resources and inculcates learning.

Several publications are available on various technologies for improving library services, but we have listed only a handful in Table 3 that were closely related to academic libraries. The next-generation technologies are data mining, machine learning, virtual reality, RFID, NFC, IoT, and Blockchain. Assisting patrons in discovering relevant information, enriching bibliographic records, improving the visibility and discoverability of library data, and enhancing the user experience using linked data technology and semantic technologies will change the search and retrieval features of the library systems. Library 4.0 is not imaginary and will now be a reality in the future. Artificial intelligence will play a vital role in making an intelligent library. The libraries will also use analytical tools like LibAnalytics, OrangeBoy, Gale Analytics, WhoFi, etc., to evaluate and improve library services.

The most recent works linked to academic library services were also reviewed in Table 4. Improving research support services and facilitating off-campus access are the most discussed issues in the academic library. As the research landscape develops and researchers' needs diversify, more and more services emerge, such as research consultation, research guides, research data management, and so on, necessitating the organization of research support services. All these studies indicate that research metrics, open access, and scholarly communication have been a priority for academic libraries.

Materials and Methods

This study is a systematic review of literature from 2010-2022, having significance in the futuristic approach which will influence academic libraries in various dimensions. The study accumulated published literature on various innovations concerning its influence on academic librarianship. Google Scholar, LISTA, Emerald, Scopus, etc. databases were searched to identify research papers. Articles were retrieved using the keyword "future of academic library." We found the future of the academic library can be categorized into "collection development," "space planning," "space management," "library and information services," "emerging technologies," and "library leadership." Hence, further literature searches were carried out in this group of keywords; and a total of 70 papers were reviewed in this study. The non-English language papers and the research papers related to the "public library" were also excluded from the study. The development and differences considered in the academic libraries were studied and highlighted. Many of the research papers were recently published, which indicates that, for the academic libraries to be efficient and effective, there should be an analysis and assessment of various components to survive.

Table 1
Collection Development

Author/s	Keywords	Application based on the reference
Boté & Termens (2019)	Datasets, research datasets, special collection	The inclusion of datasets will enhance the unique library collection.
Carter (2019)	SERU, licenses, NISO	Libraries should negotiate and offer license changes, and vendors should use SERU instead of a negotiated license.
Jabaily (2020)	Cost-per-use, cost-effectiveness, COUNTER, Unsub, usage reports	Using COUNTER and Unsub will result in improved usage counts and a considerable recalculation of cost-per-use calculations.
Katz (2019)	Open educational resources, affordable course content, zero textbook cost, academic libraries	Acceptance of open educational resources shall be a good choice for lowering the cost of textbooks and increasing access and affordability to learning content.
Levenson & Nichols Hess (2020)	Collaborative collection development, collection management, cooperative collection development, coordinated collection development, collective collections	Collaborative Collection Development (CCD) can fulfill the essential role of library collection management by improving access to various relevant resources while being cost-effective.
Levine-Clark (2019)	Academic libraries, collection management	Future libraries will include Demand-Driven Acquisition (DDA) for collection development supporting collaboration, which consists of a wide range of available content and the institution's content.
Linden, Tudesco & Dollar (2018)	Collection development, inter-institutional collaborative networks, circulation, collection assessment	Collections as a service can become more common within inter-institutional collaborative networks.
O'Gara & Osterman (2019)	Big Deals, journals, library consortia, open access, pricing models	VIVA's strategy intends to link the current subscription model and a visioned future of expandable open-access choices.
Scott, Harrington & Dubnjakovic (2021)	Open access, scholarly communication	OA resources can be a good part of library collections, and libraries must formulate policies to ensure an intentional and systematic approach to OA.
Wahl (2017)	Streaming video, collection development	Users have grown accustomed to video content being available via Netflix, Hulu, and Amazon Video, and as a result, streaming video is becoming a feature of academic library collections.

Table 2
Space Planning

Author/s	Keywords	Application based on the reference
Allison et al. (2019)	Learning commons, academic libraries, circulation, inter-library loans, database usage	The library can initiate learning commons in an academic or research library on circulation, document delivery, inter-library loan requests, and on- and off-campus database access.
Barton (2018)	Learning commons, mixed-methods approach, academic library	The learning commons service model is based on fulfilling the digital generation's integrated learning demands.

Author/s	Keywords	Application based on the reference
Bell & Kennan (2021)	Digital humanities, academic librarianship, critical librarianship	Library nurtures digital humanities by sharing values of librarianship and the societies related to the critical and theoretical foundations of the digital humanities.
Dowson (2016)	Libraries, research commons, digital scholarship, communities of practice	The Research Commons concept encourages interdisciplinary collaboration in a modern library and provides holistic support services to researchers throughout the research life cycle.
Flores, De Leon, & Valerio (2021)	Library spaces, user-centered, academic commons	Collaborative, sanctuary, interaction, and community spaces were devised to organize library facilities.
Gregersen & Moxnes (2019)	Academic libraries, library space, library redesign, tracking the traffic, visual traffic sweeps	User-centered design methods (UX) can be used to get information about the use of the premises and the needs and wishes of our students.
Hauke (2017)	Green Library, sustainable development	A library can contribute to achieving sustainable development goals by opting for the green concept.
O'Kelly (2017)	Library facilities, interior space, architecture, learner engagement, academic libraries	Engagement culture, core connectedness, environmental messages, and transformative challenges are four crucial aspects to consider when planning library space.
Purpur, Radniecki, Colegrove & Klenke (2016)	Makerspaces, innovation, entrepreneurship	The library can use the full potential of Makerspace in supporting teaching, learning, collaboration, and innovation.
Zaugg & Warr (2018)	Creativity, innovation, design	Creativity, innovation, and design (CID) studio might be installed within the library space to support instructional activities.

Table 3
Futuristic Technologies

Author/s	Keywords	Application based on the reference
Bagchi (2020)	Conversational software; chatbot; conversational AI; dialogue management; natural language processing; Rasa OpenStack; information retrieval; human-computer interaction	Encourage the library to adopt novel library chatbots, like Rasa, an AI-powered open-source conversational software.
Cox, Pinfield & Rutter (2019)	Academic libraries, data mining, artificial intelligence, machine learning	Intelligent library to develop the potential to capture the goodness of artificial intelligence.
Frost, Goates, Cheng & Johnston (2020)	Virtual reality, extended reality, mixed reality, user experience, libraries	HTC VIVE, Oculus Rift by Facebook, and Google Cardboard are potential futuristic tools for the library.
Fu (2020)	Blockchain, BlockMetrics, biometrics, library management	BlockMetrics is the integrated technology using blockchain and finger-vein biometrics, which can be adopted into a library collection management and access control system.
Gul & Bano (2019)	Smart technologies, smart libraries, ambient intelligence, augmented reality, data mining	Regarding users, technological integration, services, and emerging smart technologies can impact library efficiency.

Author/s	Keywords	Application based on the reference
Harada (2017)	Robotics, artificial intelligence technology, Japanese library, pepper	Pepper, a guiding humanoid robot developed by Softbank and the robot suit HAL (Hybrid Assistive Limb), is used in Libraries in Japan and is an encouraging sign for other libraries.
Igbinovia (2021)	Internet of Things, smart library, RFID, library technology	IoT can be utilized for context-based factors such as organizational, technological, security, privacy, and environmental in libraries.
Jones, Briney, Goben, Salo, Asher & Perry (2020)	Library analytics, academic libraries, student success	Springshare's LibAnalytics, OrangeBoy, Gale Analytics, WhoFi, and OCLC's Wise can opt for library learning analytics.
Langley (2018)	Digital stewardship, digital curation, digital preservation, digital stewardship end-to-end workflow model, digital streams matrix, digital workflows born-digital, digital content,	The digital stewardship approach can be opted by incorporating the digital streams matrix and the digital stewardship end-to-end workflow model to handle digital content.
Noh (2015)	Web 4.0, library 4.0, massive data library, intelligent library, augmented reality, context-awareness	Library 4.0 will include intelligent technologies like context-aware technology, big data, makerspace, augmented reality, cloud service, state-of-the-art displays, and Librarian 4.0.
Ocran, Underwood & Arthur (2020)	Information and communication technologies (ICTs), mobile technologies, mobile devices, successful strategies	Users should be taught the advantages of using a mobile device to access library services, and library staff should be sufficiently trained to provide such services.
Santos & Esposito-Betan (2018)	Augmented Reality (AR), emerging technologies, library orientation programs, academic/research libraries	Creating a prototype to show how augmented reality can be included in a library orientation program.
Warraich & Rorissa (2020)	Semantic web, linked data, library data, W3C, metadata	The library can employ linked data technology to assist patrons in finding relevant information, enrich bibliographic records, improve the visibility and discoverability of library data, and improve users' overall search experiences.
Wheatley & Hervieux (2020)	Academic libraries, environmental scan, artificial intelligence, innovation in libraries, strategic planning, machine learning	Academic libraries can work on AI-based initiatives like the Digital Skills Hub, Alexa in Education, and the Artificial Intelligence Lab with other departments within their institutions.

Table 4
Information Services

Author/s	Keywords	Application based on the reference
Hansen & Courtney (2018)	Controlled Digital Lending (CDL), libraries, lending	CDL can be used as a guide to legally lend digital copies of books.
Andrikopoulou, Rowley and Walton (2021)	Research data management, academic libraries, academic librarians	RDM can be integrated as one of the library practices, which can potentially reposition the library's image and identity.
Ayre & Craner (2017)	Open data, library data, government data	The library could identify the most critical open data resources and develop programs that provide patrons with data literacy training and chances to engage with open data

Author/s	Keywords	Application based on the reference
		in new and innovative ways.
Barnes (2015)	Bibliometrics, altmetrics, social networks, Mendeley, social web, F1000Prime, research impact, scientific communication, Twitter	The library may identify new metrics based on the social web to access the research impact and enhance digital scholarship.
Borrego & Anglada (2018)	Academic libraries, open access, research support, university libraries	Facilitating research support services in academic libraries.
Bryant et al. (2017)	Research information management, curation, metadata	Research information management (RIM) is the collection, curation, and use of research information, and it is currently increasing interest and relevance in many university libraries.
Jayakanth, Byrappa & Visvanathan (2021)	Off-campus access, shibboleth, virtual private network	The library can set up a Shibboleth-based single sign-on (SSO) access management system to enable authorized users of the institute to seamlessly access licensed online resources from off-campus locations.
Piwowar, Priem & Orr (2019)	Open access, scholarly communication	The decreasing relevance of closed access papers will likely alter the scholarly communication environment in the coming years.
Whitacre (2019)	Hotspot, libraries, digital divide, internet	Libraries will provide cellular-based hotspots that link to a user's smartphone, tablet, or laptop in the future, allowing patrons to "check out the Internet."
Xie, Shen & Wang (2021)	Preprint analysis, citation impact, publication rate, time to publish, arXiv, SSRN, bioRxiv	The library can assist academics and policymakers in making well-informed judgments on how to use and embrace a preprint culture properly.

Results

The future trends of academic libraries, as illustrated in Figure 1, are categorized into four attributes: collection development, space planning, futuristic technology, information services, and management and leadership.

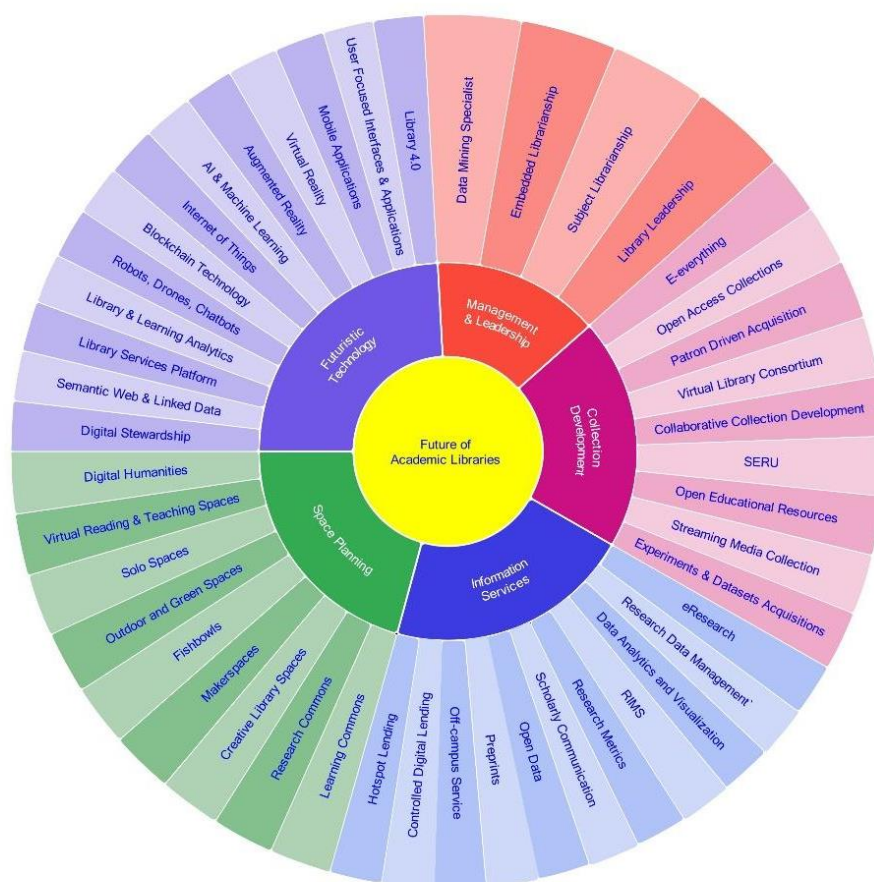


Figure 1: Future of Academic Libraries

Collection development

Collection development moves away from a "print logic" based on information scarcity toward the "network logic." The library supports access to data and information from any source or format to satisfy user needs. Academic libraries currently function in a world with less financing, more competition, and many new possibilities for obtaining high-quality resources. These realities point to the need to rethink how libraries develop collections profoundly and the essence of a library collection shown in Figure 2.

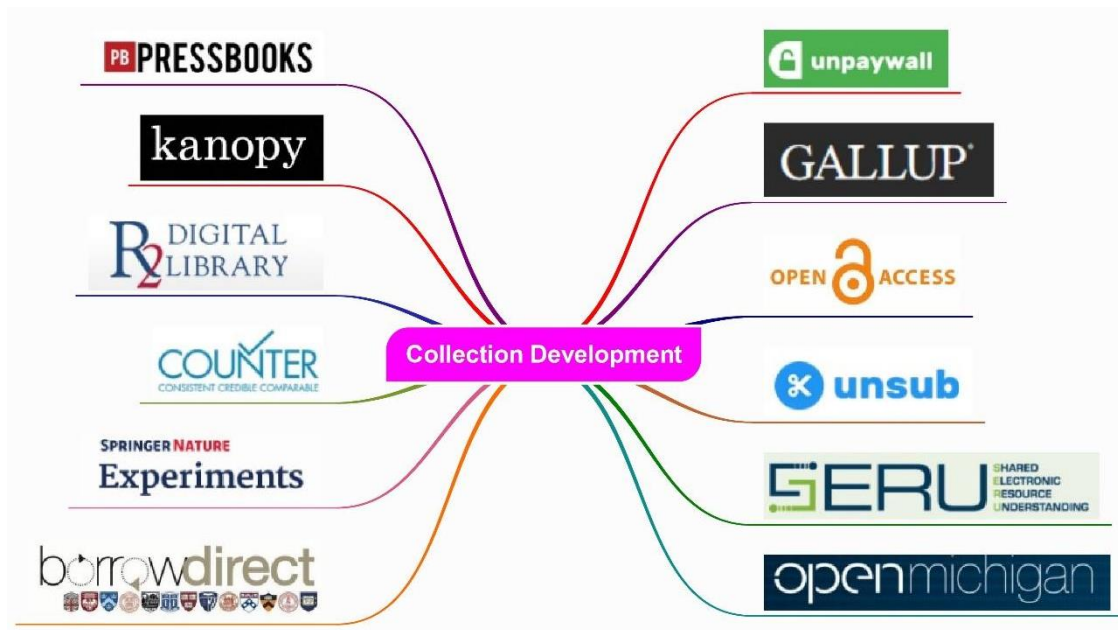


Figure 2: Collection Development

E-everything

Libraries will devote more time and resources to building electronic collections in the coming years.

Virtual library Consortium

A virtual Library system mimics a physical library's collection outline and categorization elements while adapting it to a web browser context controlled by a mouse and keyboard (Unlu & Xiao, 2021). The best example is the Virtual Library of Virginia (<https://vivalib.org/viva/homepage>), a consortium initiated by nonprofit academic libraries inside the Commonwealth of Virginia. The objective is to improve library and information resources for the Commonwealth of Virginia's nonprofit academic libraries by providing equitable, cooperative, and cost-effective access.

Patron/Demand-Driven Acquisition (PDA or DDA)

Lorbeer (2013) stated, "In the future, purchasing large bundles of electronic book content could become non-existent, replaced by demand-driven acquisitions." For over a decade, librarians have used Patron/Demand-Driven Acquisition (PDA or DDA). Rather than having librarians choose books, library users are asked to determine which books they think are required or beneficial for the collection. Patron Driven Acquisition (PDA) program of the R2 Digital Library (<https://www.r2library.com/>), a precision collection development tool that uses patron usage statistics of premier health sciences eBooks added to an R2 collection without requiring an automatic purchase or any upfront expenses.

Although most libraries provide these just-in-time rentals to provide users with the quick access they demand as a Short-Term Loan (STL), analyzing the catalog log is another aspect to find the user demands based on the denial request or null result. The log Analysis was used to measure the use of PDA e-books. Catalog log data can be collected from the Apache Web server logs recorded for the library catalog website for the respective year (Urbano, Zhang, Downey

& Klingler, 2015).

OurResearch, a nonprofit organization that recently developed Unsub (<https://unsub.org/>), is a data dashboard and prediction tool that assists academic libraries in canceling their subscriptions to costly bundles of toll-access journals. Unsub integrates thorough information about subscription history, journals by subject, ILL queries, faculty citations, and other indicators to assist organizations in making informed selections.

COUNTER (<https://www.projectcounter.org/>) provides the Code of Practice that facilitates publishers and vendors to record usage of their electronic resources consistently. COUNTER statistics can give the details of use. Checkout/check-in statistics are available for print books through library management systems. E-books can generate statistics at the chapter level and measure the downloads.

Shared e-resource understanding

The Shared E-Resource Understanding (SERU) (<http://www.niso.org/standards-committees/seru>) was introduced by National Information Standards Organization, which provides libraries and publishers with a mutually advantageous alternative to negotiating and forming a licensing agreement, looking at the libraries' and publishers' business needs rather than their legal ones. Carter (2019) suggested that the libraries negotiate and make changes to licenses more frequently and request vendors to use SERU instead of a negotiated license.

Collaborative collection development

Collaborative collection development (CCD) provides more opportunities to fulfill the prominent role of collection management, providing improved access to various resources in the most cost-effective manner possible as academic libraries face acquisition budget challenges (Levenson & Nichols Hess, 2020). BorrowDirect is an example of CCD, a resource-sharing network that has proven to be an effective and efficient way of meeting institution needs for borrowing print collections. Wu (2019) proposed broader access to collections and a national collaborative library to level the search field.

Open access collections

Academic libraries are engaged in open-access activities such as managing the institutional repository with open-access content, digitizing and making their print collections available, and their digital library with open-access collections. Unpaywall (<https://unpaywall.org/>), Open Access Button (<https://openaccessbutton.org/>), and Paperity (<https://paperity.org/>) are prominent tools that include millions of records of open content from publishers and libraries and support open access discovery filters.

Open educational resources (OER)

Libraries will have to incorporate OERs into the online catalog, which will reduce some of the financial burdens. Open textbooks were considered a possible solution to the textbook affordability crisis. The prominent resources are Pressbooks (<https://pressbooks.com/>), an online platform for creating and publishing open textbooks. The University of Michigan's OER collection, known as OpenMichigan (<https://open.umich.edu/>), has the features of teaching & learning resources and experiences from faculty, students, staff, and partner institutions.

Streaming media collection

As online education grows, teachers and students will increasingly rely on multimedia content for their teaching, learning, and research needs (Wang & Loftis, 2020). Subscribed video collection vendors such as YouTube (<https://www.youtube.com/>), Alexander Street Press (<https://alexanderstreet.com/>), Naxos (<https://www.naxosvideolibrary.com/>), Kanopy (<https://www.kanopy.com/>) provide access to extensive collections of streaming media content at a relatively low cost per title.

Experiments & datasets acquisitions

Foster, Rinehart and Springs (2019) piloted the purchase of research data sets, enabling the libraries to procure large-scale data sets for high-level research endeavors while also exploring concerns around licensing, technical deployment, support, and evaluation in an institution. Springer Nature Experiments (<https://experiments.springernature.com/>), Gallup Analytics (<https://www.gallup.com/home.aspx>) is a subscription-based platform with over a decade of international public opinion data from more than 160 nations and areas.

Space planning

Library Space Planning guide explains the unique building requirements for academic libraries by introducing some of the facilities and considerations at play in the design of 21st-century academic libraries, as shown in Figure 3.



Figure 3: Space Planning

Learning commons

The library becomes a laboratory for creating knowledge in the learning commons concept (Lee Roberts, 2007). Learning commons is a tech-infused, comfortable, and flexible learning place with a one-stop academic assistance center in the University of Iowa Library (<https://www.lib.uiowa.edu/commons/>). There includes a café, Food for Thought, and various reservable learning and teaching rooms and places.

Research commons

The Research commons model has recently evolved inside academic libraries to facilitate research practice change in the digital era. This model provides specialized services, spaces, and technologies throughout the research life cycle to help students, research scholars, and faculty (Dowson, 2016). At Simon Fraser University Library (<https://www.lib.sfu.ca/about/branches-depts/rc>), the Research commons supports a collaborative, creative, and cross-disciplinary research culture that is empowered and transformational.

Creative library spaces

The term "creative library spaces" was coined by (Johnson, 2016), which refers to various types of library spaces that focus entirely on creating content rather than just consuming content. Drawings and photographs, audios, videos, 3D objects, programmed electronic devices, computer coding, multimedia, and more are examples of nontextual content created in creative spaces within a library. The Innovative Media Studios (IMS) at the Virginia Commonwealth University School of the Arts (<https://qatar.vcu.edu/library/about-us/innovative-media-studios-ims>) is dedicated to media equipment and studio spaces that support interdisciplinary application and promote extensive range of experimentation. Media Design Studio at the Virginia Tech campus (<https://lib.vt.edu/create-share.html>) provides various hardware and software to develop all media projects, including video, audio, and other multimedia.

Makerspaces

Makerspaces in academic libraries allow hands-on training, collaboration, STEM activities, prototyping, tinkering, and exposure to an open space (Burke, 2015). Users can use shared equipment and resources to create digital and physical objects in typical working environments. Lawrence University Library (<https://www.lawrence.edu/library/departments/makerspace>) provides students with hands-on experiences and can develop a concept from an idea to a physical object.

Fishbowls

The Fishbowl is a unique seminar room encouraging open discussion and focus on cross-disciplinary, collaborative learning and research. The Fishbowl at NC State University Libraries (<https://www.lib.ncsu.edu/spaces/fishbowl#access>) is a collaborative education and research space.

Outdoor and green spaces

Living walls are covered with plants, bringing nature inside and enhancing the library's air quality. Indoor fountains, terraces, skyline reading rooms, and garden reading lounges are some spaces that give users the sense of being outdoors (Nitecki, 2011).

Solo spaces

Single seats with a tiny table in hallways and corners encourage independent study. To create solo study rooms, consider oval-like seating, which partially hides a student's head and torso. This chair form reduces movement distractions by dampening noise and restricting a student's peripheral vision (Bieraugel, 2019).

Virtual reading and teaching spaces

Virtual reading rooms and teaching spaces provide human-mediated, remote access to library resources that are not digitized. Scholars and students can visualize and digitally connect with an institution's heritage and cultural collections via live streaming via visualizers present within physical reading rooms, requesting a staff member to position these to enable their research or learning (Greenhall, 2021).

Digital Humanities

Digital humanity is a new collaborative discipline that applies digital tools and technologies to traditional humanities items and approaches. Academic libraries promote digital humanities capabilities, including geographic information system (GIS) mapping, visualizations, and text mining, altering the humanities study at colleges and universities worldwide. Cambridge Digital Humanities is an interdisciplinary research center at the University of Cambridge (<https://www.cdh.cam.ac.uk/>).

Futuristic technologies

We explore the technologies that will impact academic libraries, from core values such as open technologies and sustainability to more novel innovations such as AI, IoT, Blockchain, and robots, as shown in Figure 4.

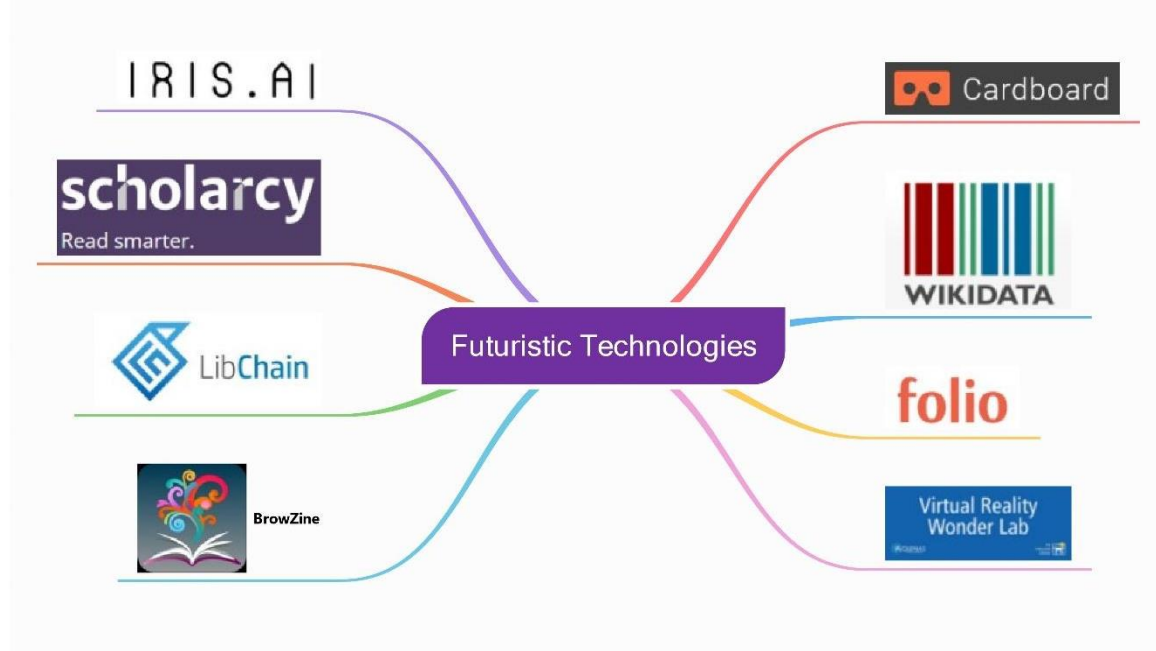


Figure 4: Futuristic Technologies

Library 4.0

Library 4.0, nicknamed the "aesthetic and emotion-rich" library, is being proposed. It is considered a luxurious area for meditation, relaxation, and idea production. According to (Schultz, 2006), the library 4.0 experience will include "a new model, knowledge spa: meditation, relaxation, immersion in a luxury of ideas and cognition." Many experts feel that Library 4.0, as a future library, will become an intelligent library based on debates on Web 4.0.

User-focused interfaces and applications

User-focused interfaces and applications provide value-added services to library users. A personalized interaction between the user and the system is one of the future possibilities of library services. Libraries will use technology to provide a digital experience for the user, whether it is an interactive game projected onto the floor for users to interact with, digital exhibitions displayed on screens, large screens in libraries that can be used to provide various types of information as well as inspire users to locate specific books. Fujitsu designed FingerLink (a digital interface for printed books), which delivers all digital functions on a

printed book.

Mobile applications

Many mobile apps and websites are available, with library catalogs, virtual library tours, borrowing and reserving services, interactive guides, event calendars, and viewing e-books and articles. BrowZine is an app for smartphones and devices that helps you flip through the subscribed and open-access e-journals available through Libraries. Custom library apps such as Capira and Library Anywhere provide personalized, convenient, and user-centric mobile apps for libraries.

Virtual reality

Virtual reality is an immersive, interactive, digitally generated world that closes your vision and places the user within it. VR systems such as the HTC Vive, Oculus Rift, and Google Cardboard entirely immerse users in a 360-degree digital world.

Augmented reality

Augmented reality (AR) is a mobile-based technology that lets users see a layered, computer-generated enhancement to their real-world vision. Users are immersed in an augmented view of reality, combining digital components with the natural environment. librARi, an image-based AR app that allows users to find books with AR interaction, points to the new additions, related books, and locations in the physical space.

Artificial intelligence (AI) & Machine learning (ML)

AI and ML technologies allow libraries to develop optical character recognition of texts and chatbots. Natural Language Processing (NLP) services such as Google Assistant, Voice Searching, and Google Translate are employed. Text data mining and other pattern recognition algorithms are also utilized to obtain library materials and conduct web searches. HAMLET, an experimental discovery interface for MIT theses and Aida, analyses digitized historical artifacts and examples of how machine learning may be utilized in image analysis. Iris.ai and Scholarly are some of the other tools of AI which support research activities in academic institutions.

Internet of Things

IoT can be used in libraries to improve user experience. RFID, NFC, wireless communication devices, sensors, energy harvesting technologies, cloud computing, and improved Internet protocol are essential technologies that enable IoT. It has the potential to transform library buildings into smart buildings, where users can interact with various items in the library and obtain nearly any type of information via communication-capable devices (Pujar & Satyanarayana, 2015).

Blockchain technology

Blockchain technology is utilized to establish an upgraded metadata structure for libraries, track digital ownership, and connect networks of libraries. Fu (2020) proposed the BlockMetrics library, built on integrated technologies such as blockchain and finger-vein biometrics, and integrated into collection management and access control systems. Image

recognition, RFID, and wireless sensor technologies also manage the library collection. LibChain (<https://libchain.github.io/>) is a distributed library management system based on blockchain technology.

Robots, drones, chatbots

In many aspects, technology has advanced libraries; they have begun to use robots instead of humans in different activities, particularly time-consuming tasks. The 'Robbie' robot developed by the Temasek Polytechnic Library can scan more than 32000 books per day. Another robot named 'Bobbie' of the same library can deliver materials like newspapers, magazines, and brochures and welcome and direct guests & students to various locations. The drone could transport library materials to people who cannot visit the library due to a handicap or a vast distance. Chatbots are virtual agents that provide a self-service option for online users in information services by providing them with basic library information such as locations, hours, inquiries, and resource requests.

Library analytics

Library Analytics is a dashboard that combines library data to allow librarians and users to spot patterns and changes in collections, usage, and other information. It will enable libraries to identify, analyze, and display activity patterns across many libraries, such as checkouts, returns, and recent acquisitions. Library Analytics and Metrics Project (LAMP) developed a shared library analytics service for UK academic libraries.

Learning analytics

Universities exploring learning analytics (LA) approaches to increase return on investment develop behavioral and academic interventions to promote student achievement. Academic libraries use LA to demonstrate value to stakeholders, assess learning gains from education, and examine student library usage. The Library Learning Analytics Project (LLAP) is collaborative research led by the University of Michigan that examines how academic libraries influence learning.

Library Services Platform

Library Services Platform (LSP) is the next-generation system of library management that provides the functionalities to better manage our collections in all formats. FOLIO is a collaborative effort with OLE, EBSCO Information Services, and Index Data to create a new open-source library services platform that will revolutionize library technology. WorldShare Management Services (<https://www.oclc.org/en/worldshare-management-services.html>) and Alma (<https://exlibrisgroup.com/products/alma-library-services-platform/>) are some of the other LSP tools for academic and research libraries.

Semantic web and linked data

The Semantic Web is the next generation of Web technology. Using Linked Data, this Web of Data allows for connecting data sets across data silos on the web, allowing for machine-to-machine communication. Thalia (http://nactem.ac.uk/Thalia_BI/) is a semantic search engine that explores 27 million abstracts from PubMed. Examples of large, linked open data sets are DBpedia and Wikidata.

Digital stewardship

Digital stewardship supervises and administers the operations and infrastructure associated with the creation, description, maintenance, preservation, and dissemination of the Libraries' unique digital resources so that users can access them for many years. Syracuse University Libraries recently established the Department of Digital Stewardship as the next initiative in the current development of its Digital Library Program. Marcel Breuer Digital Archive and Belfer Latin American 45s are some of the successful digital projects initiated by them.

Information services

Library in the future will have to assist patrons in acquiring the correct information at the right time. The service will help them become aware of recent tools for scholarly communication and research management, as shown in Figure 5.

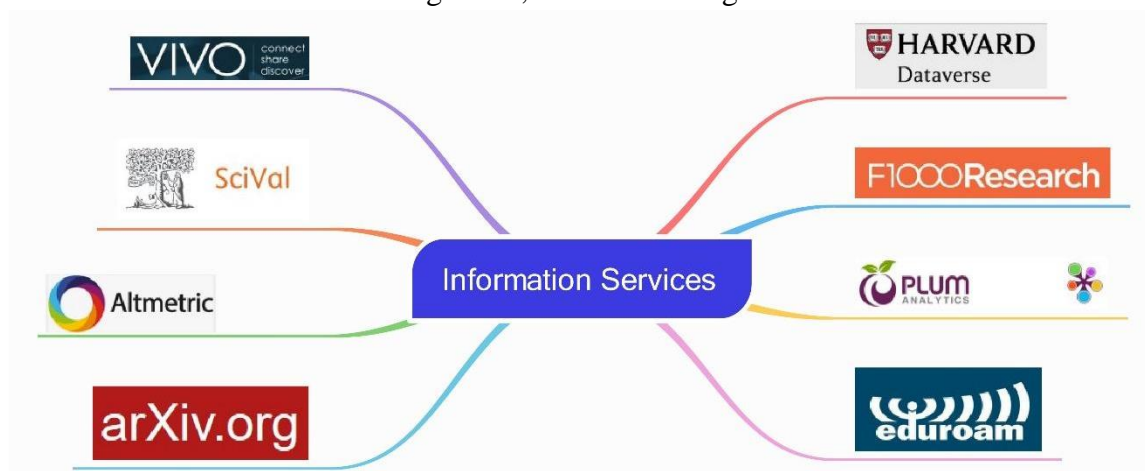


Figure 5: Information Services

Research support

The library's position has always been that of a distributor of scholarly communication, but that is rapidly changing; the second decade of the twenty-first century necessitates that the library plays a more significant role in the research process by offering a new set of services. eResearch support is the use of information and communication technologies in research. The critical areas include collaboration, visualization, and research data management.

Research Data Management (RDM)

RDM is one of these areas where libraries can assist academics as they publish research. Libraries providing RDM services can significantly impact their institutions by supporting research communication, improving knowledge of the data life cycle, offering disciplinary and institutional resources, and emphasizing the role of documentation in data sharing (McLure, Level, Cranston, Oehlerts & Culbertson, 2014). The Harvard Dataverse Repository (<https://dataverse.harvard.edu/>) is an open-source data repository where researchers share, preserve, cite, access, and study research data. It is open to all researchers from any discipline, inside and beyond the Harvard community.

Data analytics and visualization

Data is generated from various sources, including the web, social media platforms, and databases. It is becoming more vital to analyze these data and visualize the insights to aid data-driven decision-making. Penn State University Libraries' Research Informatics and Publishing department opened a digital lab equipped with computers loaded with special software, including Tableau, Microsoft Power BI, SQL Server, Access, Python, R, SPSS, STATA, SAS, ArcGIS, and MATLAB for providing services for data analytics and visualization. LibInsight (<https://www.springshare.com/libinsight/>) is valid for recording and analyzing library statistics and data points. All library data are stored on one platform, and cross-dataset analytics are used to define data-driven decision-making.

Research Information Management System (RIMS)

RIMS collects and stores academic research and intellectual activity data of a single university to repurpose the data in various ways. Academic institutions have installed systems that track faculty publications and scholarly activities, such as Activity Insight (<https://www.watermarkinsights.com/our-approach/faculty-activity-reporting/>), Pure (<https://www.elsevier.com/solutions/pure>), VIVO (<https://vivo.lyrasis.org/>), Converis (<https://clarivate.com/webofsciencegroup/solutions/converis/>), and Symplectic Elements (<https://www.symplectic.co.uk/theelementsplatform/>). These systems provide a comprehensive picture of an institution's research and intellectual activity and tools for faculty collaboration, promoting their work, and preparing annual reviews, promotion, and tenure reports.

Research Landscape Analysis (RLA)

Academic libraries should use RLA platforms like Thomson Reuter's InCites and Elsevier's SciVal to analyze the institutions' research performance management. Both tools offer citation data, worldwide research indicators, and multidimensional profiles of the world's most prestigious research organizations. The tools can also discover funding sources and suitable collaboration partners by examining institutional and individual research performance.

Research metrics

Research metrics are to quantify and track the value of published research. Citation metrics are utilized in various university ranking and accreditation methodologies; These metrics can be obtained from Web of Science, Scopus, and Dimensions. Altmetrics summarises the amount of attention a publication receives on social media and other platforms, providing helpful information on effects outside of scholarly publishing and early predictors of potential citation intents. Two commonly known alternative metrics are Altmetrics (<https://www.altmetric.com/>) and PlumX Metrics (<https://plumanalytics.com/>).

Scholarly communication

Informal models are rising, indicating intriguing new avenues that could revolutionize scholarly publishing. Web annotation (<https://web.hypothes.is/>) is gaining attraction as an emerging way of collaboration, peer review, and other research functions. Elements (<https://www.cambridge.org/core/what-we-publish/elements>), a concise, peer-reviewed guide to recent topics across all research areas from Cambridge University Press, is an excellent alternative to traditional journals and books channels.

Open data

Open data range from data repositories where authors can publish data sets. Dryad (<https://datadryad.org/stash>) is an example of an open-source project on data publication and digital preservation. An example of open government data is World Bank Open Data.

Preprints

Preprints such as arXiv (<https://arxiv.org/>), chemRxiv (<https://chemrxiv.org/>), and F1000 Research (<https://f1000research.com/>) continue to be essential products of digital scholarship.

Off-campus service

Off-campus service is significant and practically required for user efficiency and academic performance. Users prefer to use electronic library resources and other applications remotely from home, work, or the library's wireless environment on a laptop. Highwire Press has partnered with Google Scholar to create CASA (Campus-Activated Subscriber Access). This tool offers a federated identity system that would do away with IP authentication and proxy servers, enabling users to log in once and be recognized across all platforms.

Controlled digital lending

Hansen & Courtney (2018) published a white paper that explained Controlled Digital Lending as the following:

"CDL enables a library to circulate a digitized title in place of a physical one in a controlled manner. Under this approach, a library may only loan simultaneously the number of copies that it has legitimately acquired, usually through purchase or donation. Essentially, CDL must maintain an owned to loaned ratio. Circulation in any format is controlled so that only one user can use any given copy at a time for a limited time. Further, CDL systems generally employ appropriate technical measures to prevent users from retaining a permanent copy or distributing additional copies."

Many libraries currently use CDL platforms, for example, MIT (Open Library via Internet Archive) (<https://archive.org/details/mitlibraries-ol>) and HathiTrust Emergency Temporary Access Service (<https://www.hathitrust.org/ETAS-Description>).

Hotspot lending

Hotspot lending can resolve the information access problem at a maximum level. The wifi hotspots are available for checkout at libraries. The hotspot allows library patrons who do not have access to the internet at home to connect to the internet. Students, professors, and researchers working and studying remotely will access a free and dependable internet connection through the lending program. Portable hotspots provide internet access to wifi-enabled devices such as computers, tablets, and smartphones. The Montana State University Library has provided six hot spots as part of its hot spot lending program. eduroam (<https://eduroam.org/>) is a global service that allows students, researchers, and staff from participating organizations to connect to the internet while on campus and when visiting other participating organizations by simply opening their laptops or turning on their smartphones or other portable devices over wifi.

Management and leadership

Library leadership

Libraries are eager to build leadership potential, and many librarians participate in various leadership programs. On the other hand, leadership development involves far more than episodic training; libraries and librarians require systemic and strategic planning. Libraries do not appear to establish strategic leadership development or conduct conscious succession planning (Wong, 2019). As the role of technology in libraries has expanded, tech-savvy librarians are primarily working side by side in complex digital environments (Maceli, 2018).

Emotional Intelligence

An emotionally intelligent leader is mindful of managing emotions, is highly empathic, and maintains good relationships with others in the library (Martin, 2018).

Catalyst for change

Leaders who are comfortable with change can also initiate and facilitate necessary change in their libraries needed in the profession. A catalyst for change must be innovative, open-minded, and eager to investigate and consider all a library offers. Being a change agent necessitates a leader to be "entrepreneurial," not only in taking risks but also in recognizing a need for a service gap and filling that need, whether or not it is something a library does traditionally. In addition to being a competent communicator, a change leader must be trustworthy (Martin, 2018).

Collaborative leadership

Empathetic and collaborative leadership is becoming more critical for library leaders in research libraries and higher education. The most successful crowdfunding efforts are collaborations and partnerships between library management and staff (Dewey, 2020).

Subject librarianship

Subject liaison librarians are responsible for building and administering collections, references, instruction, and outreach in their assigned fields. They must be renowned experts and professional librarians knowledgeable about library operations (Luckert & White, 2019).

Embedded librarianship

Embedded librarianship takes a librarian out of the usual library environment; It positions them in an "on-site" setting or situation to work closely with researchers or teaching faculty. Librarians use the embedded librarianship approach in their information literacy programs to overcome the constraints of the "one-shot" library training class. The John Hopkins University Welch Medical Library is developing "embedded liaison" programs that place librarians within the departments they serve to increase the frequency and depth of librarian-faculty interactions and better understand the faculty's needs through direct observation (Carlson & Kneale, 2011).

Data mining specialist

Librarians can provide data mining as an additional service in the research toolbox to mitigate the data scientist shortage. Data mining specialists are the library community trained

in curating, preserving, and archiving data.

Discussion

Academic libraries are encountering increasingly unexpected challenges in today's networked information society, and thanks to changing features, online search engines and creative information mediums help to survive. After assessing contemporary academic libraries from five distinct perspectives, the paper emphasizes the driving factors that will affect the architecture and operations of academic libraries in the future.

Academic libraries likely relied on collections to access the materials required to fulfil academic goals. The idea of a "collection" needs to be redefined; more dynamic access concepts will emerge for the limitless stream of information during the next decade. Libraries must rethink their collection techniques in radical and perhaps stringent ways to thrive the core objective of the academic institution. The concept of "facilitated access" will become an essential service, not limited to local collection; it will be a global collection. This has prompted interest in right-sizing investments in the print collection, from local to shared settings, licensed electronic resources, consortia, and demand-driven licensing models.

An information commons would be a place to access, use, and develop knowledge rather than merely a reference area with rows of computers. It could provide transparent user services rather than a site of service points. The Commons idea may increase student learning, provide a social and academic atmosphere, and develop campus community. Explaining the information commons' relationship to learning and establishing the required services and atmosphere may help justify the expenditure and create a popular campus library.

Shortly, investments in new and emerging technologies such as virtual reality, augmented reality, blockchain, the Internet of Things, and service adaptations may be pricey. They are, nevertheless, vital for maintaining relevance to communities and the general notion of giving technology to the place of need. The idea of "point of need" has grown to encompass an academic community in which substantial portions of the user population may use the library and its services anytime and from any place.

The research support services emphasize acquiring and controlling massive datasets, digital artifacts, and open, networked platforms. As a result, academic libraries must transfer their strategic emphasis from collections to services since research 2.0 depends on their support services and researchers' efforts. It fosters new types of networking and encourages scientific research openness. Academic libraries must fulfill their service objectives, given how researchers and librarians understand the role of libraries and librarians in supporting research 2.0. In the future, librarians can comprehend and analyze information from anywhere. Beyond the profession, they may provide context. They must be good communicators, strategic thinkers, and listeners who understand the new ways users work and consume information, distinct from today's roles. Libraries will no longer be enticed to develop all critical skills in the present or future librarians but will build multi-specialist teams. In this climate, librarians must cooperate with experts to provide innovative and compelling content in print and digital formats.

Conclusion

This study will help academic librarians compete with other public and special librarians in exploring various facets of academic librarianship by examining collection development,

space planning, futuristic technologies, information services, and leadership perspectives. The main contribution of this research is categorizing the areas of academic libraries in the criteria for evaluating futuristic goals. This analytical perspective poses questions about how the future is and how academic librarians conceptualize it. Futuristic studies will continue to evolve to offer more valuable indicators for assessing the use of academic libraries. This study addresses this gap, focusing not on emerging trends or strategic planning but on considering how academic libraries conceive the future and the factors underlying their responses to it. All these challenges are significant steps that help define academic libraries' future.

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